NOVEMBER, 1936

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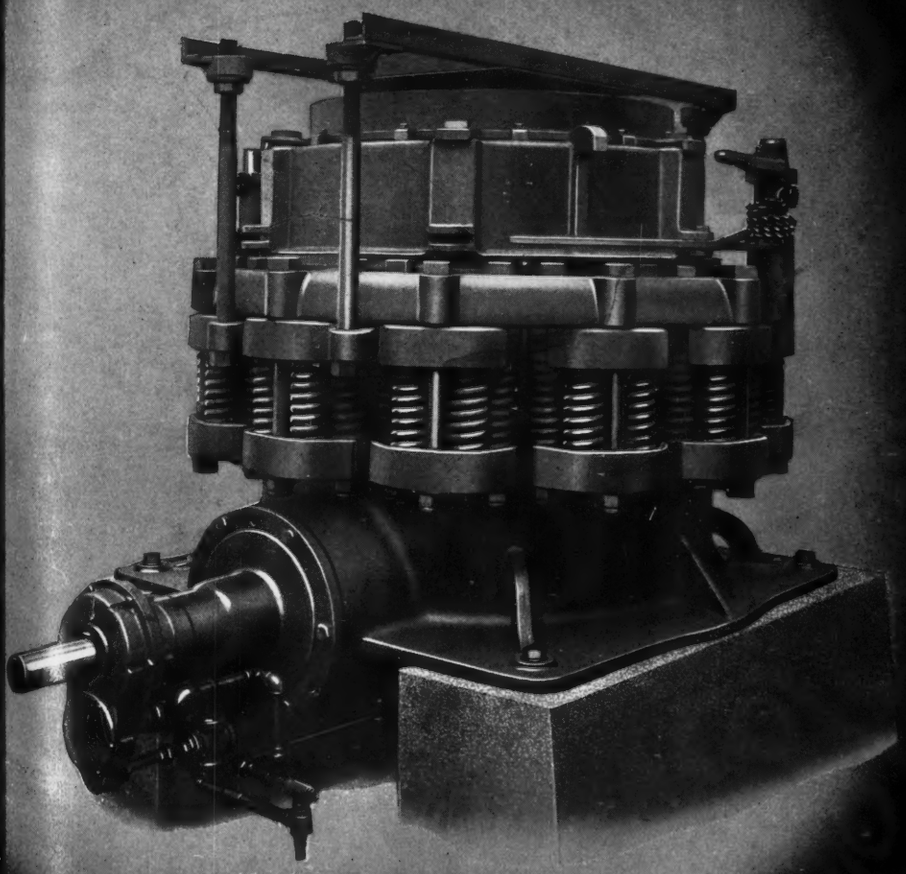

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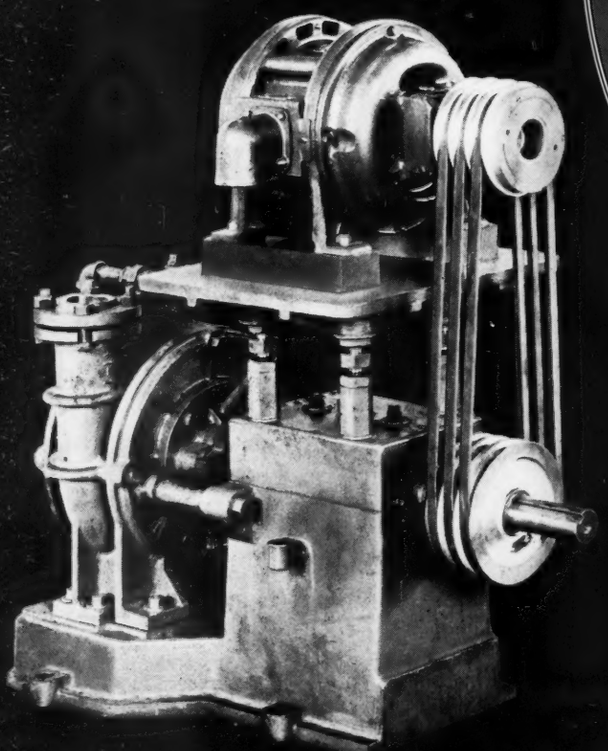

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Taxation testimony, by D. A. Callahan, of Idaho, in hearings on the Revenue Bill of 1936: "As I sat here and listened to some of the testimony offered, I marveled that there are to be found men with brains sufficiently convoluted to devise such a measure. I am afraid if the bill had to be approved by the Securities and Exchange Commission under the truth-in-securities law it would not pass muster. It is more complicated than any prospectus issued by a fraudulent promoter that I have ever seen."

✻

"Boondoggling" is the name of a new game which just has been patented. It is patterned after the game "Monopoly," but the objective is to spend money rather than to amass it. Each player is given a billion dollars at the start. As he moves chips designated by names such as Harry, Harold, and Rex, around the board, the player has opportunities to finance numerous projects such as a national caterpillar count and studies of rainspout water. The game was not conceived in political quarters. It is the creation of two young men in Washington whose concern is entirely commercial.

✻

Bonus spending is supposed to have amounted to one billion dollars. Those who are watching the effect of this disbursement of funds are agreed that there has been little or no concentration of spending on any single item. Not more than 5 per cent of automobile buying or more than 2 per cent of retail trade since June 15 can be credited to the bonus. Most of the money went into such diversified channels as to produce no notable result. A very general conclusion has been reached that, however important the bonus payment may be from the standpoint of national finance, it is not so important from a business point of view.

Mining Barometer. Explosives consumed in mining ore in the United States during the first six months of 1936 amounted to 30,626,874 lb., according to the Institute of Makers of Explosives. This was 8,577,167 lb. more than was used in the same period of 1935 and showed the greatest percentage gain of all explosives-consuming industries. California led all states in this use of explosives, consuming 3,742,153 lb. Michigan and Minnesota followed closely.

✻

Industrial Research. Modern progressive industries spend as much as several percent of income on research as insurance against decay. Over 300 years ago Francis Bacon, wise philosopher, described the fate of the industry that neglects research when he wrote: "That which man altereth not for the better, Time, the Great Innovator, altereth for the worse." Probably there were in his day, as now, so-called hard-headed business men and financial controllers who decried expenditure for research in favor of immediate profits.

✻

Measuring Settling Rates of mineral suspension is a phase of ore dressing which attracts the attention of flotation operators and metallurgists. An article covering this subject, written by A. W. Fahrenwald, professor of metallurgy, and J. Newton, assistant, at the School of Mines, University of Idaho, will appear in an early issue.

✻

A Cornish engine that has been in service for 110 years at the Levant mine, Cornwall, has been acquired by public subscription, according to our London contemporary, *Engineering,* and will be preserved in its own engine house. Its cylinder is 24 in. in diameter and the stroke is 4 ft.

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Functions of the American Mining Congress

LOOKING BACK at the Denver meeting of the American Mining Congress, one finds much to commend and little to criticize. In providing a forum for discussing questions of public policy affecting the business of mining, the Congress crystallizes industry opinion and unifies the aims of its members. As an agency for expressing the collective opinion of the mining industry on economic and legislative matters, it is a useful and indispensable organization. And finally, as a medium for shaping sound public policies and protecting the industry against unintelligent and destructive legislation, the Congress executes the collective wishes of its constituents through national headquarters at Washington. In short, its major functions are well defined, legitimate, and useful.

These activities of the Congress are sufficiently large and important to engage its entire attention. Nor should they be diluted by excursions into related fields, however attractive. Two examples will suffice to illustrate the point.

On the program at Denver were a number of papers dealing with the technology of mining and ore dressing. As a whole they received scant consideration, which was unfair to the authors. This was due principally to an overcrowded program that was essentially economic in character. The two subjects—technology and economics—do not mix well, nor are they usually suited to the same audience at the same session. In our judgment the Congress might well leave the field of technology to the American Institute of Mining and Metallurgical Engineers, which has long been established and recognized as the technical and professional body of the mining industry. The Institute is the best medium for the presentation and discussion of mining technology, just as the Congress is the logical forum for questions of public policy affecting the business of mining. The Institute confines its activities definitely to its function and the Congress may well follow the example.

Another item on the Denver program was a proposal that the American Mining Congress establish and appoint a "Mineral States Committee." The function of this committee would be to assemble statistical information on the magnitude and importance of the mineral industries of each State, and prepare such information for public release by the American Mining Congress. The object of the work would be to increase the public prestige of the mining industry and promote its welfare. We hope the American Mining Congress will resist the proposal regardless of any merit it might have under other auspices. We doubt if it is the function of the Congress to publicize the mining industry, and we foresee a vast amount of energy diverted from the major purpose of the Congress if it makes a serious excursion into this field of activity. Much of the work proposed for the committee is already being done by State bureaus, surveys, mine commissioners, and geologists, as well as by the Federal Bureau of Mines and the Geological Survey. Voluminous reports are available to the public if it wants them. To dress up this material for more palatable public consumption would not only be a tremendous task, but would call for channels of distribution beyond the capacity of the Congress to provide.

Reference has been made to overcrowded programs, and on this subject we venture to suggest fewer sessions for reading papers. Morning and afternoon meetings for four successive days are not to the liking of the average convention attendant. He doesn't go altogether for that purpose. He wants also to visit with old friends, make new acquaintances, and join with groups in the hotel lobbies. And if, as at the meetings of the Western Division, there is an exhibit of mining and metallurgical equipment and supplies, he wants time to see what the manufacturers have to offer. The latter also are entitled to more consideration than they receive when continuous sessions are in competition with the exhibits.

The American Mining Congress has a well-defined function in the mining industry and it ought to stick closely to its task. It is doing its major job well. A little improvement in its convention technique will work to its own advantage and to the pleasure and profit of those who attend.

Tailings Disposal And Stream Pollution

ON A RECENT TRIP through Colorado mining districts it was evident from observation, as well as conversation, that the disposal of mill tailings has become a matter of major concern to some operators. Restrained by law from polluting streams, all operators have had to devise means of impounding tailings, and some have found it at once difficult and expensive. Few, however, are inclined to question the essential justice of the regulation, recognizing the plight of the farmer who finds slime-burdened water ill suited to watering his stock or irrigating his land.

The precipitous character of some of the mining areas aggravates the problem. Dams must be perched, sometimes precariously, on steep slopes. Money must be spent continuously, not only on dam maintenance but on pumping a waste and worthless product that the operator would like to get rid of without cost. At one mill it is necessary to use centrifugal pumps to elevate tailings as much as one hundred feet, and at another the tailings are dewatered by vacuum filter and elevated by belt conveyor. At still another the job of maintenance at times calls for more labor than is employed in the mill. And always there is the possibility that some of the slimy muck will start to slide in spite of all precautions.

Ingenious methods are used in building the retaining walls of tailings ponds, depending on local conditions. Usually an effort is made to distribute the coarser sand along the outer wall and the slime to the center of the pond. Occasionally the sandy walls are reinforced with young evergreen trees and branches laid along the rim, where they are gradually embedded as the wall builds up. Cribbing filled with branches may be used on the lower wall where the slope is steep. At one mill the retaining wall was built of sacks of tailings laid in a pattern said to be used in levee construction. So the problem is being solved in various ways, but always with an additional item on the cost sheet, and in some cases worry over a possible disaster.

Conditions in Colorado offer no exception to the growing sentiment against stream pollution by any form of industrial waste. Two bills on the subject were introduced at the last session of Congress, providing for nation-wide prevention of stream pollution. They failed of passage because of lack of agreement on the supervising agency. But some such measure seems certain of passage at the next session of Congress, and mill operators throughout the mining areas should be prepared to keep tailings out of streams even if no State regulations exist.

Toward a Better Engineering Profession

IN MAKING PUBLIC its first list of accredited engineering curricula in colleges in the New England and Middle Atlantic States, the Engineers' Council for Professional Development has given tangible evidence of its capacity to exert a marked influence on the future development of the engineering profession. Thirty-five institutions in eleven states voluntarily submitted their curricula and facilities to inspection by visiting committees of ECPD, with the result that 135 curricula were considered worthy of recognition. Encouraged by the conspicuous success of this undertaking in the East, the process of inspection and accrediting will be extended immediately to the remaining areas of the country. Accrediting policy and procedure were discussed editorially in our July number.

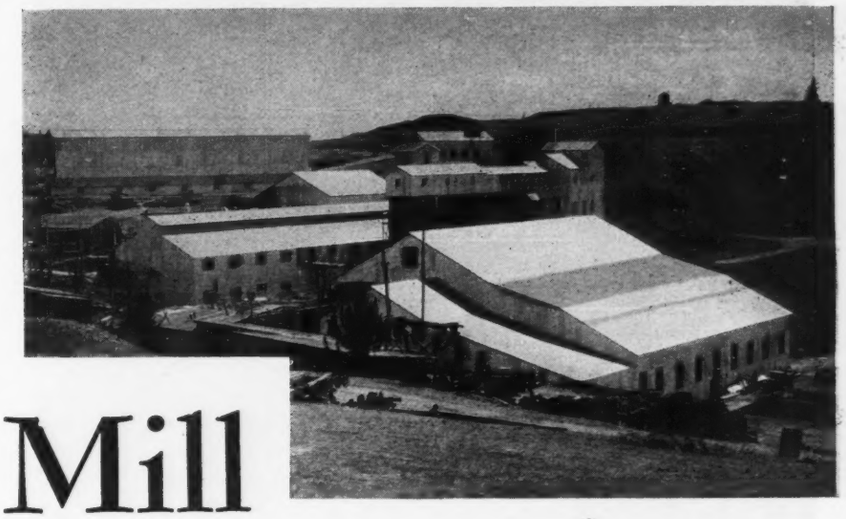
This activity is only one item in the program of ECPD, which seeks to promote and correlate uniformly high standards for technical training, society membership, and registration. In short, a program to integrate the educational, technical, and legislative phases of an engineer's life—all in the interest of better engineers and engineering. That progress is being made in this direction is evident from the reports presented at the fourth annual meeting of ECPD last month.

In a commendable effort to select better-qualified students of engineering, educators are conducting original research in aptitudes that promises encouraging results. If they can start the process of education with better raw material, they should be able to turn out a consistently better product, more certain to meet the exacting demands of those who need engineering services. But the finished product of the engineering school is still raw material out of which the working engineer is to be developed. And so another project of ECPD involves plans for post-college training and development, through contact with mature engineers and study courses of a broadening and cultural character. The acme of this progressive advancement of the individual is, of course, public recognition of his status as an engineer as evidenced by his society membership and by registration.

The program is an ambitious one but not impossible of accomplishment. Much has already been achieved. In the four years of its existence ECPD has progressed, haltingly at first, but more rapidly and with greater assurance in the past year. Having no power or authority except as it derives them from its constituent bodies, it must of necessity move slowly in its job of coordination, composing differences of opinion, dispelling prejudices, and allaying suspicion. Given the consistent support of its member organizations, of which AIME is one, it will go far toward making better engineers and gaining public recognition for a unified engineering profession.

Charles E. Tonry
Mill Superintendent,
Cripple Creek Milling Company,
Cripple Creek, Colo.

CUSTOM ORES, including the entire output of the Stratton Estate, which is handled under contract, constitute the feed supply of the new flotation-cyanidation plant of the Cripple Creek Milling Company, here seen. The mill has been in operation about a year



A New Mill At Cripple Creek

Equipped for flotation, roasting, and cyanidation, primarily to serve local mines, it is ready to handle any custom ores

INTENDED chiefly to handle gold ores of the Stratton Estate and independent producers of the Cripple Creek district of Colorado, the new treatment plant built by the Cripple Creek Milling Company in the latter part of 1935, following the organization of the enterprise by James Owen, of Denver, earlier in the year, is equipped as a custom mill to treat any and all ores. It was erected by the E. L. Sweeney Construction Company.

The mill comprises three units designed to handle the several different classes of ore found at Cripple Creek. Certain ores are susceptible to flotation with favorable results; some may be cyanided direct with excellent extractions. The present flowsheet will soon be altered to handle all of these ores. Most of the Cripple Creek ores have to be roasted to obtain satisfactory results by cyanide. Inasmuch as gold is the only element occurring in commercial quantities, the cyanide process appears logical. The plant therefore was designed to roast all those ores which could not be treated satisfactorily by flotation and to cyanide the roaster calcines. All flotation concentrates are treated in like manner.

Ore Supply and Haulage—The largest source of ore for the mill is the Stratton Estate. This property embraces over 600 acres of practically virgin ground well situated in the known mineralized areas of the district. On it there are such well-established mines as the Logan, American Eagle, Orpha May, Los Angeles, Abe Lincoln, and Geneva. In addition to these well-defined and actively mined ore deposits there are numerous smaller operations and many development projects, all of which, together with the mines already mentioned, are being operated on leases from the Estate.

In addition to the "leasers" on the Estate, a goodly number of independent mine operators are to be found in the district. Many of these ship to either the Golden Cycle mill, at Colorado Springs, or to the new Cripple Creek mill. Grade of ore and comparative ore purchase schedules have much to do with the decision as to where the ore shall go.

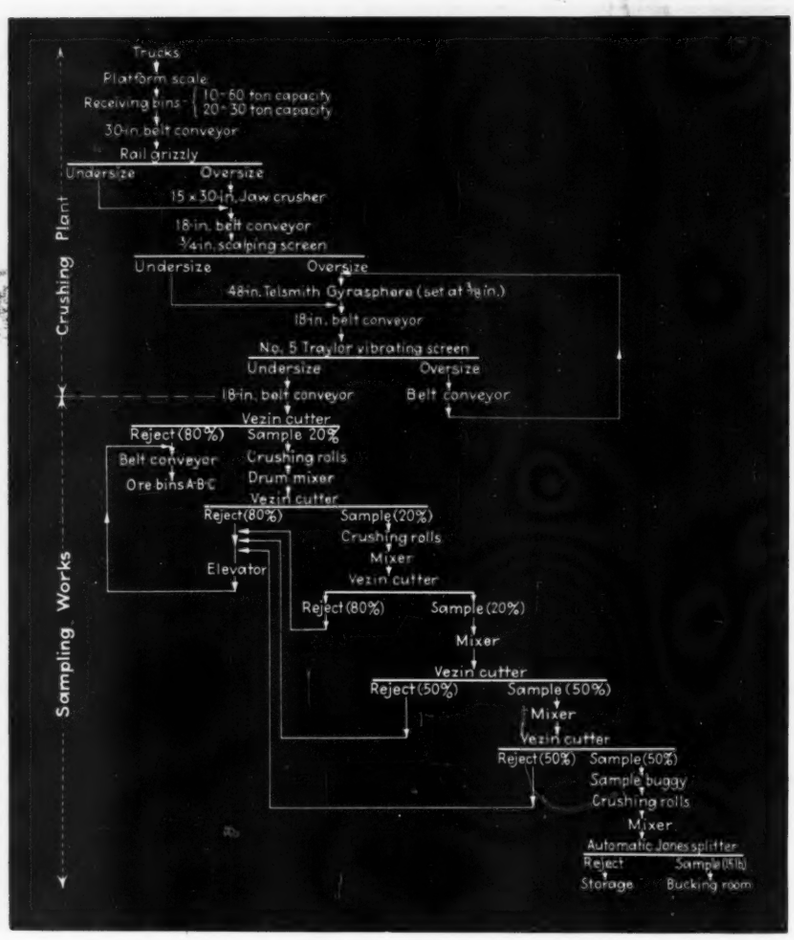
The entire Stratton Estate production is sold under contract to the Cripple Creek mill. All other ores are bought on open schedule.

Cripple Creek mining practice is based on a so-called "split-check." By this method the miner agrees to develop and extract all ores in a given block of ground, the owning or operating company furnishing certain items (generally the air, tools, and hoisting facilities and sometimes the ammunition). Upon shipment of the ore, the owner or the operating company splits the check (or net proceeds) from the mill with the miner on some prearranged basis (generally 50-50). This practice is followed almost entirely in the district, there being, however, a few exceptions.

All ore is hauled to the mill by truck. The current trucking price schedule is based on a mile-ton. The first mile-ton costs 25c. if drawn from chutes at the mine. If the ore has to be "mucked" into the truck, there is an additional charge of 20c. per ton. Each mile over the first calls for an additional 10c. per ton. The average truck load is 4 tons. A few trucks haul 9-ton loads.

Sampling and Crushing—Because of the operating system just described, all shipments of ore to the mill, even though from the same mine, must be kept separate and handled separately until sampled. For this purpose the mill has thirty receiving bins. Ten of these have a capacity of more than 60 tons and are used for assignment to the producers of large lots, such as the large dump operations and the larger mine operations. The remaining twenty bins have about 30 tons' capacity and are used for the shipments from small leases.

All trucks are weighed before and after emptying into the assigned bin and the weight of ore taken from the re-



SAMPLING THE ORE in the mill from numerous operations in the Cripple Creek district includes the passage of crushed ore through five mixers each preceding a Vezin sampler. Each sample is ultimately cut down to about 0.2 per cent of its original weight

cording scale (of 100-ton capacity) is entered on the scale report on that particular lot. Each truck is thus recorded until the lot is closed, at which time the scale report is totaled for total weight of ore and sent to the settlement clerk.

As the truck is unloaded, the bin attendant takes a grab sample for moisture, which is kept in an air-tight container. At the closure of the lot this container is sent to the bucking room, where the per cent of moisture is determined. This moisture is reported, by lot number, to the settlement clerk.

Before a lot is drawn from the bin for crushing and sampling, it is graded and designated to one of the three inside bins, according to its metallurgical characteristics and the method of treatment prescribed for it. This procedure is important, because all ores are different, even those from the same mine, and the metallurgical results depend to a great extent on the correct classification and designation of the ores previous to crushing. Inasmuch as all Cripple Creek ores are similar in appearance, much of this classification must be done on a knowledge of the behavior of these ores in the various circuits gained through actual operating experience or careful previous test work in the ore-testing laboratory.

Receiving bins are arranged in two rows on either side of a 30-in. belt conveyor and are equipped with rack-and-pinion or arc gates so as to feed onto this belt. This belt delivers the ore to a rail grizzly, the undersize of which drops on an 18-in. belt conveyor.

Oversize of the rail grizzly goes to a 15x30-in. Blake crusher, which delivers its product to the same 18-in. belt conveyor. This conveyor delivers its load to a ¾-in. scalping screen, the undersize of which goes to No. 3 conveyor, which is likewise an 18-in. belt conveyor. The oversize of the scalping screen goes to a 48-in. Telsmith Gyrasphere set to produce a ⅜-in. product. This goes to No. 3 conveyor also, and is delivered to No. 5 Traylor Conveyan-screen-type vibrating screen equipped with a ½-in. cloth. This screen is in closed circuit with the Gyrasphere, so that all the ore must pass through it before leaving the crushing plant.

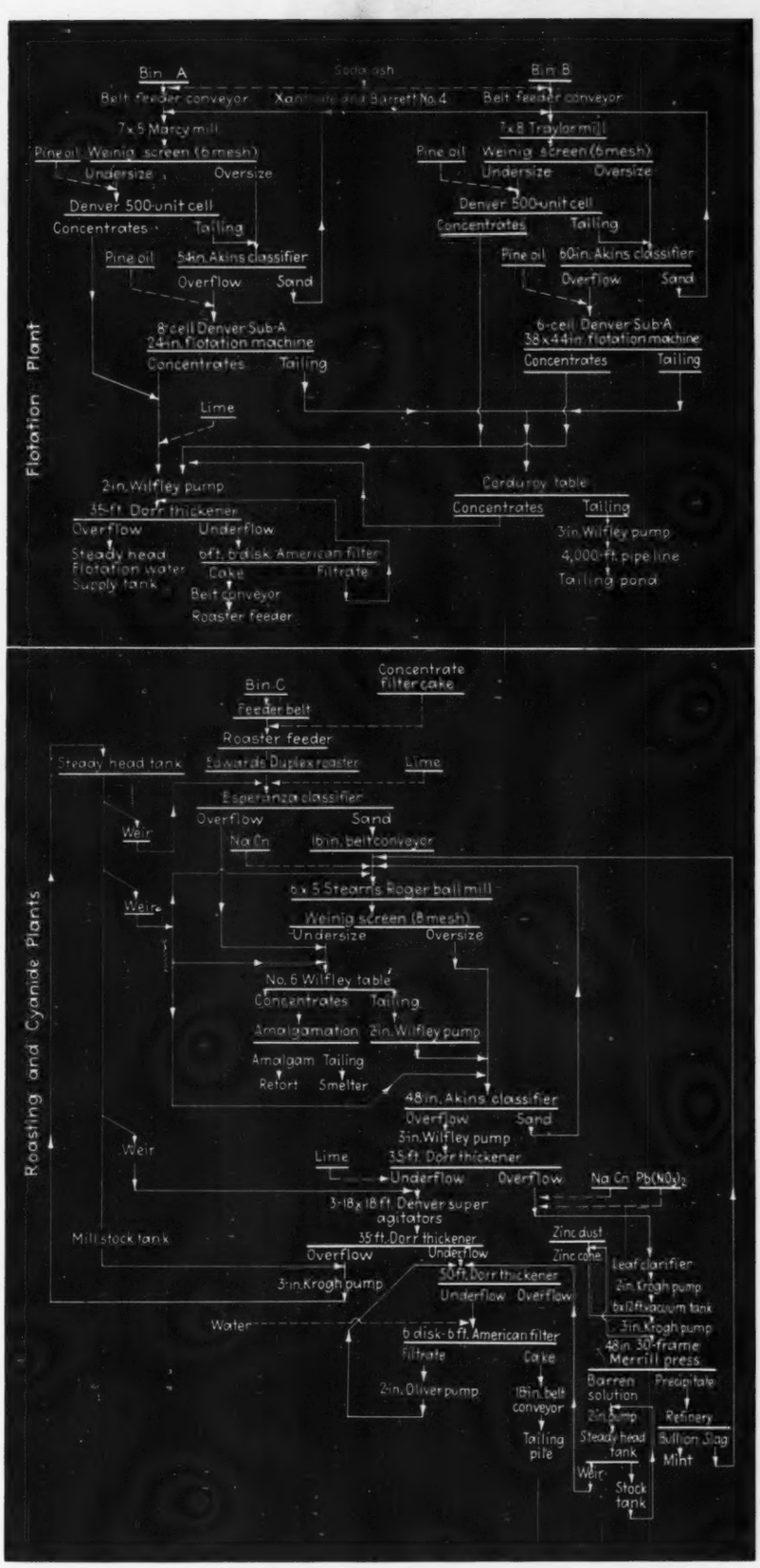
The ⅜-in. product of the finishing screen is delivered to an 18-in. conveyor for delivery to the sampling works. Here the ore passes through a series of five Vezin sample cutters preceded by mixing barrels and is cut down to about 0.2 per cent of its original weight. The sample buggy containing the last cut is taken to the bucking room, where the sample is put through a set of sample rolls and is then placed in a mixing barrel. This mixing barrel is arranged to feed a Jones riffle splitter which oscillates across the stream of ore as it is dumped out of the mixing barrel. One pan of the sample so cut is placed in a metal container. The other pan is returned to the mixing barrel and the procedure repeated as many times as necessary to produce a final sample of about 15 lb. All rejects from this work are placed in the metal container mentioned and it is then wheeled into the reject storage room, where it is held until its contents have settled.

The 15-lb. sample is placed in an electric drying oven, where all moisture is expelled, and is then further ground in an Engelbough ("coffee mill") grinder and finally through a McCool pulverizer. The sample is carefully split with Jones riffle cutters between these operations and is finally screened through a 150-mesh screen and divided into four equal parts, and the pulps so obtained are marked and sealed. One of these pulps is for the shipper, one for the mill control assayer, and two are held in reserve (umpire and record).

Settlement—Inasmuch as all ores are bought by the mill, there are two schedules of treatment rates, one to cover the Stratton ores, which are bought under contract, and the other applying to outside producers. The method of settlement for the precious metals in the ore is the same in both cases. All the gold is paid for at the rate of $32.76 per ounce based on the Government price of $35 per ounce and subject to change should the Government price in-

Table I—Treatment Rates at Cripple Creek Milling Company's Mill

		Open Schedule	Stratton Schedule
Zero to and including	$5.00 per ton	$2.50	$2.25
$5.01 to and including	8.00 per ton	3.00	....
5.01 to and including	6.50 per ton	....	2.75
6.51 to and including	8.00 per ton	....	3.00
8.01 to and including	10.00 per ton	3.50	3.25
10.01 to and including	12.00 per ton	4.00	....
10.01 to and including	15.00 per ton	....	3.50
12.01 to and including	15.00 per ton	4.50	....
15.01 to and including	20.00 per ton	5.00	4.00
20.01 to and including	25.00 per ton	5.50	4.50
25.01 to and including	30.00 per ton	6.00	5.00
30.01 to and including	35.00 per ton	6.50	....
30.01 to and including	40.00 per ton	....	5.00
35.01 to and including	40.00 per ton	7.00	....
40.01 to and including	50.00 per ton	7.50	....
40.01 to and including	100.00 per ton	....	6.00
50.01 and over		8.00	....



FLOWSHEET of the Cripple Creek company's 500-ton flotation-cyanidation plant, where ores are treated by one of several methods, depending upon their metallurgical characteristics. In the flotation plant (top of page), ores which give better yields at 65 mesh are treated in the upper left-hand circuit; those giving the same yields at 150 mesh are treated in the right-hand circuit. The plant is designed to roast all ore which cannot be treated satisfactorily by flotation, and roaster calcines are treated by cyaniding

crease or decrease. Fifty per cent of all the silver is paid for—after one ounce has been deducted from the settlement assay—at the Government price on date of assay. Moisture is penalized at the rate of 10c. per ton for each per cent over 10.

The schedule of treatment rates is given in Table I, on page 548.

Milling Operation—As previously stated, the ores are treated by one or more of several methods. Some may be satisfactorily concentrated by flotation. Others are susceptible to direct cyanidation. Most of the ores require roasting previous to treatment by cyanide. All flotation concentrates are roasted and cyanided.

In the Flotation Plant all ores are further classified. In this plant there are two sections identical in flowsheet but differing in the size of equipment. This division is brought about by the fact that certain ores may be ground to about 65 mesh and will yield satisfactory flotation results, whereas others must be ground to minus 150 mesh to yield the same results. Also, there are certain differences in these ores that require slightly different amounts of flotation reagents.

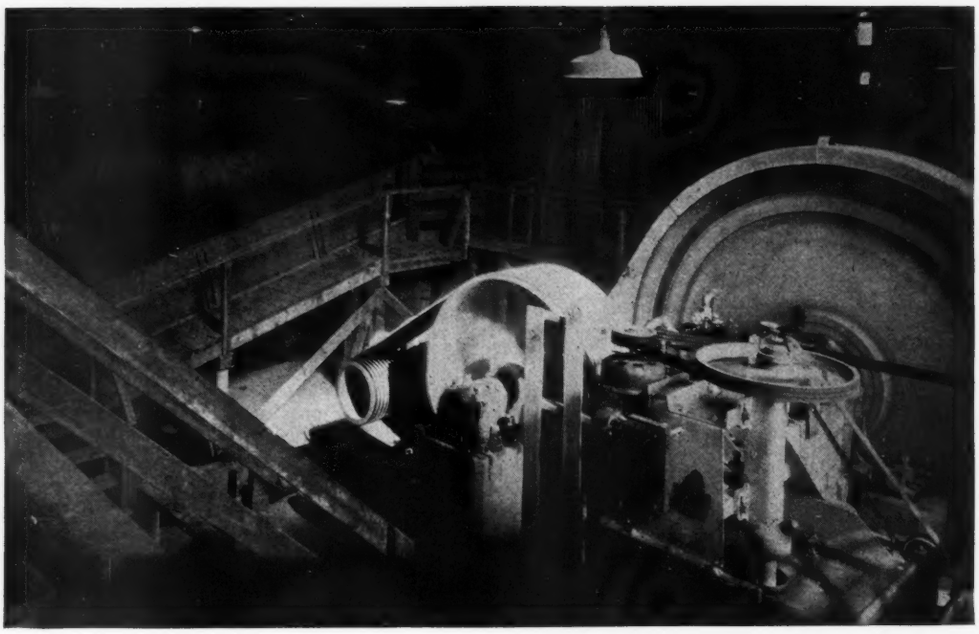
In Section 1, treating the ores susceptible to a coarse grind, the ore is fed to a 7x5-ft. Marcy mill in closed circuit with a Denver 500 Unit cell and a 54-in. Akins classifier. The trommel screen undersize (8 mesh) goes to the Unit cell at slightly less than the density of the ball-mill discharge pulp. This machine is placed in the circuit for the sole purpose of producing a coarse concentrate to be added to the other flotation concentrate. Due to the finely disseminated condition of the pyrite in the ore and the extreme friability of the telluride minerals, the flotation concentrate is quite difficult to settle and filter without the aid of the coarser material. An average assay screen analysis of the present flotation concentrate would be as given in the following table:

Table II—Assay Screen Analysis of Flotation Concentrate, Section I

	Per Cent Total Weight	Assay Oz. per Ton
Heads	100	1.72
Plus 60 mesh	12.3	0.44
Plus 80 mesh	26.1	0.84
Plus 100 mesh	20.0	1.08
Plus 150 mesh	8.9	1.24
Plus 200 mesh	8.2	2.00
Minus 200 mesh sand	5.2	4.00
Minus 200 mesh slime	19.2	4.00

The classifier overflow goes to a 24-in. eight-cell Denver Sub-A flotation machine. The feed enters the second cell, and a finished concentrate is taken off of cells 1, 2, and 3. Concentrates from cells Nos. 4 to 8 inclusive go to cell No. 1 for cleaning.

The classifier overflow at about 30 per cent solids has the screen analysis given in Table III.



IN THE FLOTATION PLANT of the new Cripple Creek mill there are two sections identical in flowsheet but differing in the size of the equipment, because some ores received require finer grinding than others. This view shows the grinding section. In the right foreground is the Unit flotation cell that is inserted in the grinding circuit

Table III—Classifier Overflow Screen Analysis, Section 1

	Per Cent
Plus 40 mesh	0.9
Plus 60 mesh	1.1
Plus 80 mesh	7.1
Plus 100 mesh	10.8
Plus 150 mesh	15.2
Plus 200 mesh	13.8
Minus 200 mesh	51.0

Section 2 differs from Section 1 in that the ball mill is a Traylor 7x8 ft. open-end mill in closed circuit with a 500 Unit cell and a 60-in. Akins classifier. The classifier overflow, at about 1.5 per cent plus 100 mesh, goes to a six-cell Economy type, size 38x44-in. Denver Sub-A flotation machine, entering the first cell. Finished concentrates are removed at cells No. 1 and No. 2 and all other cell concentrates are returned to cell No. 1 for cleaning.

At present the tailings from both sections join and flow over a corduroy table made in three sections in parallel, each 2½x20 ft. Any free gold escaping the cells is caught here. The tailings from this table go to a sump, where a 3-in. Wilfley sand pump, delivering to a 5-in. pipe line 4,000 ft. long, sends the tailings to the tailings pond.

The combined concentrates of both sections are pumped with a 2-in. Wilfley sand pump to a 35-ft. diameter Dorr thickener. Underflow of this thickener goes to a six-leaf 6-ft. American disc filter. The filter cake falls directly on a 12-in. conveyor belt which discharges into the feed hopper of the roaster. The thickener overflow returns to the flotation plant for re-use.

On account of increased tonnage in the flotation section, the time of contact in the flotation machines is not sufficient to effect complete removal of the gold. Due possibly to the existence in these low-grade dump ores of infinitesimal particles of rusty free gold which are slow in floating, long-time contact is necessary to make a sufficiently low tailing. In view of this, steps are now being taken to construct a three-cell Shimmin (air-lift type) flotation machine to take the place of the corduroy table. This machine will double the flotation capacity and will assure a uniformly low tailing assay. It will be tied in so as to act counter-concurrently; that is, the froth product of each cell will be fed back to the next preceding cell and the final concentrate will be added to the feed of the primary machines. This contemplated addition will permit a little closer classification of the ores and thus increase our roaster capacity for strictly roaster ores by allowing us to treat by flotation those partly oxidized ores which are now being roasted.

In terms of material and labor the cost of treating ore by flotation during July was as given in this table:

Table IV—Flotation Cost

Tonnage treated, 5,606.2.
Mills operated about 60 per cent of available operating time.
Reagent consumption:

Soda ash	10.6	lb. per ton
Xanthate	0.254	lb. per ton
Pine oil	0.064	lb. per ton
Aerofloat No. 31	0.047	lb. per ton
Lime	0.310	lb. per ton
Barrett No. 4	0.022	lb. per ton
Forged steel balls	2.715	lb. per ton
Labor	0.13	man-hours per ton
Power	26.2	kw. per ton
Repairs and incidentals	$0.045	per ton
Average cost	$1.027	per ton

The Roaster Plant—The Hassell-Edwards ore-roasting-furnace was designed by Frank E. Shepard and manufactured by the Hassell Iron Works, of Colorado Springs, to meet the conditions at the Stratton mill for the roasting of sulphide ores and flotation concentrates previous to cyanide treatment.

The roaster is of the duplex type, with 64 rotating rabbles in the roaster hearth, 32 rabbles in each row, followed by 16 rotating rabbles on an open cooling floor, there being 8 rabbles in each row. The roaster hearth is 13 ft. wide, inside the brickwork, by 131 ft. long, followed by the cooling floor, 13 ft. wide by 32 ft. long, with a drop of 20 in. from roaster hearth to cooling floor.

Between the roaster hearth and the cooling floor is a structural steel partition, lined with asbestos blocks and provided with adjustable openings for the admission of air to the roaster hearth. Improved bridge wall and fittings are provided to discharge calcines from the roaster hearth to the cooling floor.

The entire brickwork and superstructure of the roaster hearth and the cooling floor is supported on a reinforced-concrete slab, 18 in. thick, extending under the entire width and length of roaster hearth and cooling floor, with a fall of one-half inch per foot from the feed end of the roaster to the discharge end of the cooling floor. This concrete slab has proved effective in preserving the alignment of the brickwork of the side walls of roaster hearth and the cooling floor, and also the main arch of the roaster hearth. All the brickwork of the side walls of the roaster hearth and the cooling floor, and also of the roaster arch, is entirely of firebrick, laid in fireclay, with linings of side walls and roaster arch laid in Latex. Brickwork and arch is supported by heavy buckstays of two 8-in. I-beams, spaced 4 ft. center to center, with 1¼-in. diameter buckstay rods above the arch and below the hearth level.

The space between the top of the concrete foundation slab and the hearth level of the roaster is filled with low-grade ore crushed and screened through a 4-mesh screen. Sulphide ores and flotation concentrates to be roasted are

moved over this filling by the rotating rabbles.

Driving gear, bevel pinions and gears, rabble spindles and arms, shafting, and bearings are supported on structural steel frames with diagonal steel braces throughout the length of the roaster.

Power is supplied to the driving gear through a 25-h.p. electric motor. The rabbles in the roasting hearth rotate at 3½ r.p.m. and on the cooling floor at 7 r.p.m.

Flotation concentrates and sulphide ores are delivered by belt conveyors to a feed hopper with an adjustable gate and thence to a rotating disk with improved adjustments for regulating the feed to two lines of rabbles.

Fuel is Cañon City (Colorado) coal pulverized to minus 200 mesh by two Whiting Corporation coal pulverizers, each of these delivering pulverized coal through 5-in. diameter pipes through water-cooled burners to two fireplaces located on each side of roaster hearth, four fireplaces in all.

At present the roaster is being operated with but one fire located near its feed end. By regulating this fire and the drafts properly the roast may be made quite satisfactorily. Gases are now removed by natural draft through a dust chamber at the feed end of the roaster and thence through a long trail pipe to the stack situated at the top of the hill.

As the ore leaves the roaster it drops into an Esperanza-type classifier of local make and design. This classifier contains mill solution, and its purpose is to cool the coarser calcine so that it can be carried on a rubber-belt conveyor to the regrind mill bin. Classifier overflow, containing the calcine slimes, is run by gravity to the discharge launder of the regrind mill.

The average gas temperature in the roaster is close to 1,140 deg. F. During July coal consumption was about 147 lb. per ton of feed.

Total tonnage of ore fed in July was 3,356.5, containing 1.03 per cent sulphur. The concentrate fed amounted to 425.3 tons, containing 12.40 per cent sulphur. The calcines contained 0.37 per cent sulphur.

The average power consumption for July was 15.5 kw.-hr. per ton of feed. Average cost of roasting in July was $0.877 per ton of feed.

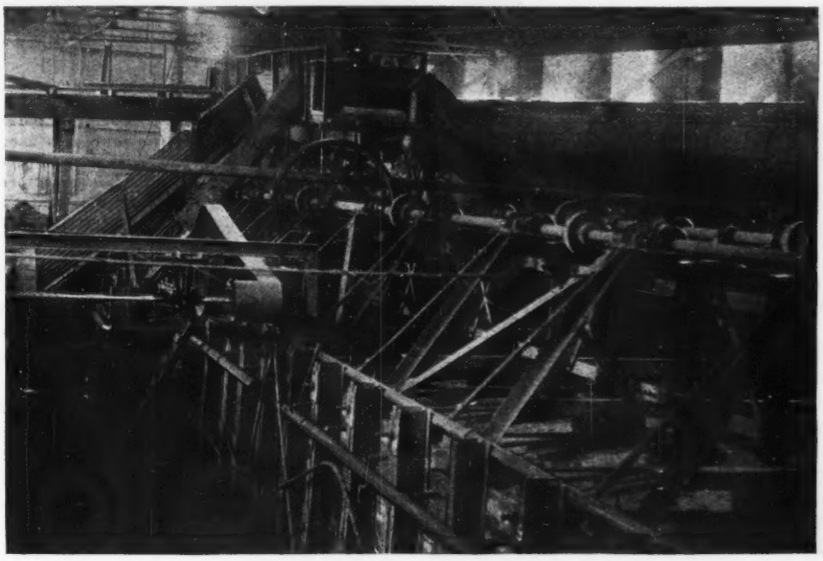
The Cyanide Plant—The coarse calcine from the Esperanza classifier is fed to a 6x5-ft. Stearns-Roger ball mill of the overflow type and equipped with a Weinig screen with an 8-mesh cloth. Steel balls are used in this mill. In closed circuit with the ball mill are a No. 6 Wilfley table and a 48-in. Akins classifier. Undersize of the Weinig screen is tabled to remove any free gold particles large enough to enter the table concentrate and the fine iron from the ball mill. This concentrate is then treated by amalgamation and the residue is shipped to the Leadville smelter.

Table tailings are combined with the Weinig screen oversize and go to the classifier. The classifier overflows at about 23 per cent solids and has the screen analysis shown below:

Table V—Screen Analysis, Cyanide Plant Classifier Overflow

	Per Cent
Plus 60 mesh	0.55
Plus 80 mesh	5.01
Plus 100 mesh	6.48
Plus 150 mesh	10.57
Plus 200 mesh	11.00
Minus 200 mesh	66.38
	99.99

(*Continued on page 570*)



THE HASSELL-EDWARDS-FURNACE, designed for the conditions met at the Cripple Creek mill in roasting sulphide ores and flotation concentrates previous to cyanidation. Power is supplied to the rabble-driving gear through a 25-hp. electric motor

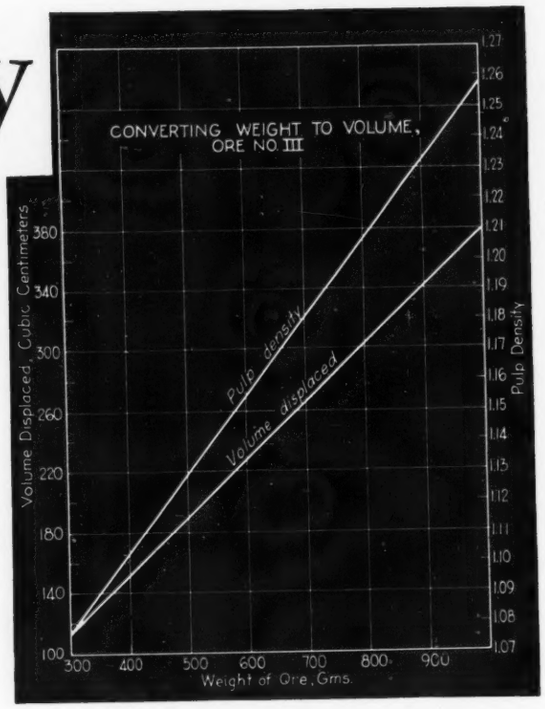
THE COOLING FLOOR of the roaster, as seen from the discharge end, with the rabbles in motion. Here there are two rows of eight rabbles each, which rotate at 7 r.p.m., or twice the speed of the rabbles on the roasting hearth

Pulp Density

As a Factor in Flotation of Gold Ores

AN EXPERIMENTAL STUDY

A. W. Fahrenwald,
Joseph Newton,
and
Patrick L. McManus



CONVERTING WEIGHT TO VOLUME, Ore No. III. For each of the four ores used in the test a graph such as this was prepared. From it, knowing the volume of ore required to give any desired pulp density, one can readily determine the weight of ore needed.

PULP DENSITY has been and is recognized as an important factor affecting flotation results. Undoubtedly, considerable study has been made of this factor by metallurgists independently and in the laboratories of various operating companies. Few data on this subject, however, have been published.

Oliver C. Ralston and Clarence R. King (*Min. & Met.*, August, 1935) have published data showing the effects of diluting a pulp in the cleaning of flotation rougher copper concentrates. These authors found that if the dilution of the cleaner feed is maintained between 20 and 30 per cent solids, recovery is a maximum, tailing is cleaner, and concentrate is of a minimum grade. L. H. Lange (*E. & M. J.*, March, 1935), among other factors considered, found, in several experiments conducted in which pulp dilution was the variable, that the flotation of free gold is best brought about in circuits of high pulp density—namely, 2.5 to 1.

E. S. Leaver and J. A. Woolf (U. S. Bureau of Mines R. I. 3226, 1934) state that "in general, coarse gold is floated more readily from a thick pulp (40 to 60 per cent solids) than from a pulp of the usual density (20 to 30 per cent solids) used for flotation feed." There may be other articles dealing specifically with the pulp density factor in flotation, but these serve to show how the problem has been attacked and in a general way the nature of results obtained. Lange, it appears, reached his conclusions on results of some half a dozen tests, and Leaver and Woolf make their statement as a result of general observations and on tests conducted on synthetic samples.

In the present investigation, nature's own ores were employed. Their sources and a statement of the character of each are given in Table I. The specific gravity of each is given for reasons to be learned later.

Samples for flotation were dry-ground. This practice was resorted to in the interest of uniformity of sieve analyses, so this factor may be known to be constant in all series of tests. If the samples had been wet-ground, it would have been necessary either (1) to have kept the wet pulp in stock over periods of several weeks, or (2) to have dried the pulp and stock the dried sample. Neither of these procedures would have corresponded to practice any more than to dry-grind, as was done.

Sieve analyses of the four ores tested are summed up in Table II. The best fineness of grinding was not a matter of concern, since relative recovery, and not maximum recovery, only was of interest. All tests were made in 500- and 2,000-gram Denver Sub-A laboratory flotation machines. The reagents used in all tests were as follows: Amyl xanthate (Great Western Z-5), Yarmor F. pine oil, and soda ash.

Technique—In our experiments it was decided to maintain in all tests a constant pulp volume. To this end the specific gravities and specific volume of the ores to be studied were determined (see Table I). The pulps (water-solids mixtures) for flotation were made up on a volumetric basis. In using pulp made up volumetrically and a constant pulp volume in the flotation machine, reagent additions may be made either (1) to give constant reagent concentration on the water, or (2) to give constant concentration with respect to the ore. It is obvious, however, that if the solute concentration is maintained constant with respect to the solvent (water), the weight of reagents per unit volume (or weight) of ore increases with increasing dilution (decreasing pulp density), whereas if the reagent is maintained constant with respect to the ore volume, the reagent concentration with respect to the solvent (water) decreases. Thus, we find that when a constant pulp volume is to be tested in a given flotation machine, two reagent factors are confronted. To recapitulate: (1) When the reagent concentration on the water is constant, there is increasing weight of reagent per unit volume of ore with decreasing pulp density, and (2) when the weight of reagent per unit volume of ore is constant, there is decreasing reagent concentration with increasing dilution.

For each ore a graph was prepared from which, knowing the volume of ore required to give any desired pulp density, weight of ore needed was readily observed. One of these graphs, (Ore No. III) is here presented.

Experimental—Employing the technique described in the foregoing, several series of tests were conducted.

Series A, Using Ores I and II—In this series pulp volume, xanthate concentration on the water, and time of frothing were the constants; pulp density was the variable. The total volume of pulp in all tests, unless otherwise noted, was 2,400 c.c. Soda ash in the arbitrary amount of 1.0 lb. per ton of ore was constant in all tests. Pine oil, a steam-distilled brand, was used as required to produce desired frothing.

Six tests were made on each ore on pulps, and with results as indicated in Table III.

For both ores, under the conditions of these tests, the gold recovery de-

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CONCLUSIONS:

1

Gold recovery was increased with increasing pulp dilution.

2

Flotation rate, in grams per minute, increased with increasing pulp dilution.

3

Quality of concentrate and, in turn, the ratio of concentration, increased with increasing dilution.

4

With xanthate concentration constant, in respect to the water, recovery decreased with increase in pulp density, and the concentration ratio increased with pulp dilution.

creases strongly with increasing pulp density. Three variables, however, are involved in this series of tests, and the variation in recovery cannot, offhand, be wholly attributed to pulp density. These variables are: (1) pulp density; (2) reagent (xanthate) concentration on the ore, the concentration decreasing as pulp density decreases; and (3) the volume (or weight) of ore treated. This variable is more appropriately stated in terms of the product of the weight of charge times the minutes of treatment.

To isolate the factor of pulp density, each of the above variables is further considered.

Series B, Using Ores I and II—Here pulp volume and the xanthate concentration on the ore were maintained constant. Pulp density, as in Series A, was the variable. The data relating to this series are found in Table IV.

Here, as in Series A, gold recovery decreases with increasing pulp density, but still, however, the result may not properly be laid entirely to pulp density, since there are two variables involved in addition to pulp density—namely, (1) xanthate concentration on the water, and (2) volume (weight) of ore treated.

Series C—This series of tests was designed to determine the effect of xan-

Table I—Description of Ores

Ore No.	Gangue Minerals	Values	Sp.G.	Head Assay	Locality	Remarks
I	Quartz. Some sulphide..	Au-Ag	2.7	0.73 Au	Elk City, Idaho...	Somewhat oxidized
II	Predominantly sulphides with some quartz, Arsenopyrite feldspar	Au-Ag	3.4	0.22 Au	Unknown.....	Partly oxidized
III	Quartz. Sulphides scarce	Au-Ag	2.63	0.26 Au	Pierce, Idaho.....	Partly oxidized Oxidized vein material
IV	Quartz, clay, sulphide....	Au-Ag	2.56	0.80 Au	Nelson, Nev.....	50% Au recovered by amalgamation

Table II—Screen Analysis, Flotation Feed

	Ore No. I		Ore No. II		Ore No. III		Ore No. IV	
Mesh Size	% of Sample	% Cum.	% of Sample	% Cum.	% of Sample	% Cum.	% of Sample	% Cum.
+ 48.....	3.22	3.22	.31	.31	5.84	5.84	.33	.33
+ 65.....	6.05	9.27	1.34	1.65	6.81	12.65	1.24	1.57
+ 100.....	12.20	21.47	7.23	8.88	11.92	24.57	9.84	11.11
+ 150.....	14.18	35.65	11.51	20.39	11.45	36.02	11.80	22.91
+ 200.....	17.60	53.25	20.87	41.26	19.42	55.44	17.00	39.91
− 200.....	46.20	99.45	58.20	99.46	44.60	100.04	59.80	99.71

Table III—Xanthate Concentration on the Water and Time of Frothing, Constants—Pulp Density Variable

Ore No. 1
(Time of Aeration, 8 Min.)

Cubic Cm. Ore	Cubic Cm. Water	Weight of Ore, Grams	Pulp Density	Xanthate Concentration: On Ore, Lb./Ton	Xanthate Concentration: On Water Grams/Liter	Recovery of Gold: Total %	Recovery of Gold: Per Min. Frothing Time	Ratio of Concentration
111.....	2,289	300	1.080	0.0864	0.00565	77.5	9.70	37–1
163.....	2,237	440	1.117	0.0574	0.00565	68.2	8.54	40–1
215.....	2,185	580	1.154	0.0426	0.00565	57.6	7.20	58–1
267.....	2,134	720	1.190	0.0336	0.00565	59.8(?)	7.48	37–1
319.....	2,089	860	1.227	0.0274	0.00565	51.0	6.39	36–1
370.....	2,030	1,000	1.264	0.0238	0.00565	45.0	5.63	25–1

Ore No. II
(Time of Aeration, 8 Min.)

Cubic Cm. Ore	Cubic Cm. Water	Weight of Ore, Grams	Pulp Density	Xanthate Concentration: On Ore, Lb./Ton	Xanthate Concentration: On Water Grams/Liter	Recovery of Gold: Total %	Recovery of Gold: Per Min. Frothing Time	Ratio of Concentration
89.....	2,311	300	1.085	0.0870	0.00565	81.0	10.10	3.5–1
130.....	2,270	440	1.128	0.0582	0.00565	71.2	8.90	4.7–1
172.....	2,228	580	1.171	0.0453	0.00565	66.1	8.26	5.9–1
212.....	2,188	720	1.210	0.0343	0.00565	60.3	7.55	8.0–1
253.....	2,447	860	1.250	0.0282	0.00565	51.8	6.48	9.5–1
294.....	2,106	1,000	1.295	0.0238	0.00565	47.8	5.98	9.8–1

Table IV—Xanthate Concentration on the Ore and Time of Treatment, Constant—Pulp Density, Variable

Ore, No. I
(Time of Aeration, 8 Min.)

Wt. of Ore Grams	Xanthate Concentration: On Ore, Lb./Ton	Xanthate Concentration: On Water, Grams/Liter	Recovery of Gold: Total %	Recovery of Gold: Per Minute Frothing	Ratio of Concentration
300.....	0.05	0.00327	60.6	7.59	37–1
440.....	0.05	0.00491	57.3	7.17	40–1
580.....	0.05	0.00663	54.5	6.82	58–1
720.....	0.05	0.00845	51.7	6.46	37–1
860.....	0.05	0.01030	38.2(?)	4.78	36–1
1,000.....	0.05	0.01230	50.0	6.25	25–1
Ore No. II					
300.....	0.05	0.00327	77.3	9.66	5–1
440.....	0.05	0.00491	70.0	8.75	4.9–1
580.....	0.05	0.00663	69.7	8.70	5.3–1
720.....	0.05	0.00845	68.1	8.51	4.8–1
860.....	0.05	0.01030	69.1(?)	8.64	4.8–1
1,000.....	0.05	0.01230	66.8	8.36	4.3–1

Table V—Pulp Density and Time of Frothing, Constants—Xanthate Concentration Variable

(Time of Frothing, 8 Min.)

Cubic Cm.: Ore	Cubic Cm.: Water	Weight of Ore, Grams	Pulp Density	Xanthate Concentration: On Ore, Lb./Ton	Xanthate Concentration: On Water, Grams/Liter	Recovery: Total %	Recovery: % per Min.	Ratio of concentration
147.....	2,253	500	1.143	0.025	0.00278	70.2	8.78	8.6–1
147.....	2,253	500	1.143	0.050	0.00560	76.7	9.59	4.9–1
147.....	2,253	500	1.143	0.075	0.00833	79.1	9.90	2.8–1
147.....	2,253	500	1.143	0.100	0.01110	89.4	11.15	2.2–1

thate concentration on recovery, and this factor, therefore, is the variable. Pulp density and all other factors were maintained constant. The data are summarized in Table V.

Here it is obvious that both recovery and rate of flotation (per cent per minute) increase with increasing xanthate concentration, and this factor cannot be ignored in pulp-density studies. Incidentally, also, it is of interest to note that the ratio of concentration falls off heavily with xanthate concentration.

Series D, Using Ore No. II—In this series two sets of tests were outlined, further to test the factor of pulp density. The time of frothing was the variable in each set. In Set One, the pulp density was constant at 1.047 and in Set Two, constant at 1.243.

The experimental data of these two sets of tests are compiled in Table VI. They show a consistantly better time-recovery curve for the set of tests for the higher dilution and a better ratio of concentration in the diluter pulp, for any given recovery.

Table VI—Pulp Density Constant in Each Set of Tests, but Variable in the Two Sets—Xanthate Concentration on the Ore Constant and Time of Frothing Constants in All Tests

Run No.	Weight of Ore, Trams	Pulp Density	Xanthate Concentration on the Ore, Lb./Ton	Gold Recovery, Per Cent	Ratio of Concentration
		Set No. 1			
1	300	1.047	.05	68.6	6–1
2	300	1.047	.05	74.5	4.7–1
3	300	1.047	.05	75.2	3.4–1
4	300	1.047	.05	76.9	3.3–1
5	300	1.047	.05	75.0	3.3–1
		Set No. 2			
1	860	1.243	.05	64.8	5.7–1
2	860	1.243	.05	69.7	4.5–1
3	860	1.243	.05	70.0	4.4–1
4	860	1.243	.05	70.3	4.7–1
5	860	1.243	.05	71.0	4.0–1

Table VII—Conditions Same as for Table VI, New Technique

Run No.	Weight of Ore, Grams	Pulp Density	Xanthate Concentration on the Ore, Lb./Ton	Gold Recovery % in Each Total		Ratio of Concentration
				Conc.	Cum.	
		Set No. 1				
1		1.292	0.05	64.0	64.0	7.7–1
2	1,000 in a 500 gram cell	1.292	0.05	5.88	69.88	5.9–1
3		1.292	0.05	3.67	73.50	5.0–1
4		1.292	0.05	2.52	76.00	4.2–1
		Set No. 2				
1		1.085	0.05	70.0	70.0	17 –1
2	1,200 in a 2,000 gram cell	1.085	0.05	4.2	74.2	11.5–1
3		1.085	0.05	1.5	75.7	9.1–1
4		1.085	0.05	1.9	77.6	7.4–1

Table VIII—Time of Frothing Variable in Each Set of Tests—Pulp Density Variable in the Series of Sets

Run No.	Weight of Ore, Grams	Pulp Density	Xanthate Concentration on the Ore, Lb./Ton	Gold Recovery % in Each Total		Ratio of Concentration
				Conc.	Cum.	
		Ore No. III				
		Set No. 1				
1		1.258	0.05	62.0	62.0	30.6–1
2	1,000 in a 500 gram cell	1.258	0.05	2.5	64.5	19.8–1
3		1.258	0.05	0.8	65.3	14.9–1
4		1.258	0.05	0.8	66.1	11.9–1
		Set No. 2				
1		1.186	0.05	64.2	64.2	40 –1
2	720 in 500 gram cell	1.186	0.05	1.2	65.4	26.5–1
3		1.186	0.05	1.0	66.4	20.8–1
4		1.186	0.05	1.4	67.8	14.4–1
		Set No. 3				
1		1.110	0.05	60.5	60.5	62.6–1
2	1,500 in a 2,000 gram cell	1.110	0.05	5.5	66.0	42.5–1
3		1.110	0.05	1.2	67.2	32.9–1
4		1.110	0.05	1.0	68.2	25.4–1
		Set No. 4				
1		1.085	0.05	70.0	70.0	17 –1
2	1,200 in a 2,000 gram cell	1.085	0.05	4.2	74.2	11.5–1
3		1.085	0.05	1.5	75.7	9.1–1
4		1.085	0.05	1.9	77.6	7.4–1
		Ore No. IV				
		Set No. 1				
1		1.250	0.05	77.5	77.5	44.0–1
2	1,000 in a 500 gram cell	1.250	0.05	5.4	82.9	22.0–1
3		1.250	0.05	1.6	84.5	17.0–1
4		1.250	0.05	1.2	85.7	12.0–1
		Set No. 2				
1		1.181	0.05	83.0	83.0	57.0–1
2	720 in a 500 gram cell	1.181	0.05	2.5	85.5	31.0–1
3		1.181	0.05	1.0	86.5	21.6–1
4		1.181	0.05	1.0	87.5	15.6–1
		Set No. 3				
1		1.077	0.05	81.2	81.2	89.6–1
2	1,080 in a 2,000 gram cell	1.077	0.05	1.8	83.0	52.0–1
3		1.077	0.05	1.2	84.2	38.0–1
4		1.077	0.05	3.0	87.2	30.0–1

Series E, Using Ore II—In this series two sets of tests, similar to those of Series D, differing primarily in experimental technique, were run. Up to this stage in the experimental work a new sample was taken for each test made. For tests, however, in which time of frothing is the variable, difficulty was experienced in obtaining data that would give smooth recovery curves. At this point a new technique was introduced. A single test (or sample) provided data for a complete "recovery-time of frothing" curve. Froth was caught for successive three-minute periods in separate pans. Each three-minute concentrate was carefully weighed and assayed. The data are found in Table VII.

These data show the same trends as those of Table VI.

Series F, Using Ores III and IV—Another group of tests on the same plan as those of Series D and E was conducted, employing the new time of treatment, recovery technique. Conditions of the tests and metallurgical data are compiled in Table VIII.

Conclusions—In this paper the results are presented of an extended and detailed experimental study of the pulp-dilution factor in the flotation concentration of gold ores. Four gold ores, more or less typical of gold ores as they run, were used in the study. Pulps were made up on a volumetric basis so that pulp volume could be maintained a constant in all tests. Reagent concentrations, with reference particularly to xanthate, and time of treatment also were taken into account in the study of the principle variable (pulp dilution).

Conclusions may be drawn as follows:

In all four ores tested, (1) the gold recovery increased with increasing pulp dilution; that is, with decreasing pulp density, an optimum dilution point was not reached; (2) the rate of flotation, in terms of grams per minute, increased with increasing pulp dilution; and (3) the quality of concentrate and in turn the ratio of concentration increased with increasing dilution.

When the xanthate concentration, with reference to the water, is maintained constant, (1) the recovery decreases with increase in pulp density, and (2) the ratio of concentration decreases with increasing pulp density.

An Old Mine

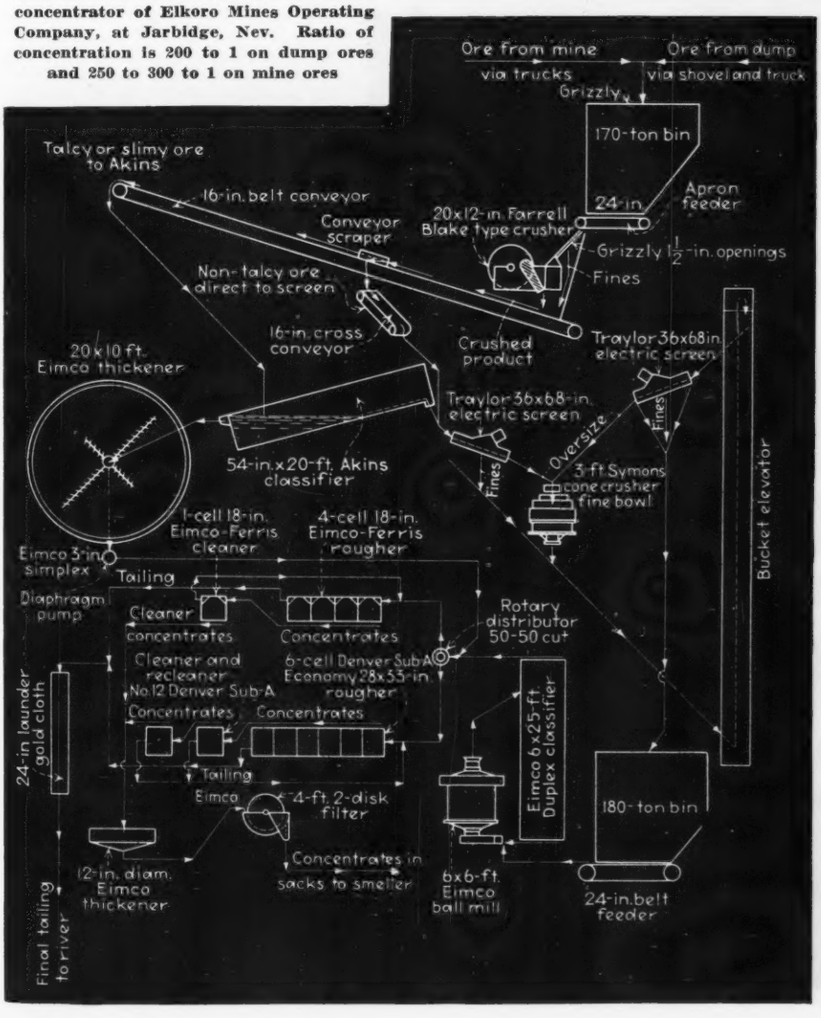
Rewards New Investment

Elkoro gold-silver property, reopened at Jarbidge, in Nevada, reveals large tonnages of pay ore

Gail Martin
Salt Lake City, Utah

EVERY MINING MAN at some time in his life has been tantalized by the dream of running across a deserted mine, reopening it, and by the discovery of new orebodies and the use of improved metallurgy bringing the old property back into the ranks of producing and dividend-paying mines. Many have the dream and work to achieve it, but few live to see their dreams realized. But once in a while the seemingly impossible happens. It seems to be happening in the case of the Elkoro Mines Operating Company at Jarbidge, Nev., in Elko County 72 miles from Rogerson, Idaho, the nearest railroad point. In November, 1932, this company acquired property aggregating about 750 acres of the Elkoro Mines Company. Intensively operated by the latter company, which belonged to the Yukon Gold Company, this property from 1918 to 1931 had produced a total of $6,807,500 in metal and made a net operating profit of $3,487,964. From a total of 613,243 tons of ore, cyanide milling had extracted 295,201.69 oz. of gold and 1,243,023 oz. of silver, an average of 0.481 oz. gold and 2.027 oz. of silver per ton. Even during September, 1932, when the mine was shut down and the mine and mill were dismantled, the company had made a profit of $22,894. But at that time the outlook was threatening and a considerable amount of money would have had to be spent to develop new orebodies, so the company decided to stop work.

FLOTATION FLOWSHEET of 250-ton concentrator of Elkoro Mines Operating Company, at Jarbidge, Nev. Ratio of concentration is 200 to 1 on dump ores and 250 to 300 to 1 on mine ores



In 1934 the Elkoro Mines Operating Company was organized by Salt Lake City men to take over the property. The incorporators were convinced that with the increased price for gold, in the 8 miles of workings that opened large tonnages of low-grade ore and on the dumps in the 75,000 tons of ore discarded from the sorting belts, there lay an opportunity to make a good profit. Several hundred tests made of the dump ore established the fact that with gold at $35 and silver around 77c. an ounce, this ore carried values ranging from $5 to $6 a ton.

The mine was reequipped, new rails were laid, and electric haulage (this being an Atlas locomotive) and a six-drill Ingersoll-Rand compressor were installed. The new equipment also includes a blacksmith and machine shop with arc and acetylene welding equipment, drill sharpeners, and all machinery necessary to make the mine self-sustaining because of its distance from the railroad. An electric power line, built in from Thousand Springs, Idaho, by the Elkoro Mines Company, met the need for power. The Jarbidge River assures a plentiful supply of water.

While a new flotation plant was being constructed to supplant the cyanide process formerly used, development work was carried on in the mine. Six adits, whose portals range from an altitude of 6,100 ft. for the lowest and 7,100 ft. above sea level for the highest, traverse the formation, consisting of a series of Tertiary volcanic flows. The ore occurs in veins cutting rhyolite. The ore minerals, according to the geologic report of Earl B. Young, geologist for the company, consist of native gold, electrum, argentite, and cerargyrite; the gangue minerals are quartz, adularia, and a small amount of pyrites and oxidation products, such as iron oxide and aluminum sulphates.

Results of developments soon exceeded the fondest hopes of the operators. Large tonnages of low-grade ore were found that with the increased price for gold and silver and improved metallurgical methods assured a profit. On the 6,100 level, a new vein, called the North Hike, never before exploited in the mine, was found to be heavily mineralized. Exploration here developed an orebody 600 ft. long, averaging 5 ft. wide, which

has been followed up for a distance of 160 ft. vertically. Estimated to contain between 75,000 and 100,000 tons, this deposit averages 0.187 oz. gold and 3.20 oz. silver to the ton.

In the Long Hike vein, one of the largest producing areas in the old mine, it was found that 4 to 5 ft. of high-grade ore had been taken out but that 25 to 30 ft. of lower grade which can be mined under conditions prevailing now had been left. With a mining cost of $2.50 a ton, a milling cost of $1 a ton, and $1 a ton charged for losses in the tailings, the company believes that this ore can be treated with profit ranging from $2 to $3 a ton. Of this type of ore, it is estimated, 250,000 tons has been developed.

After a comparatively short period, the company now finds itself in a position where it has a flotation mill capable of treating 300 tons of ore daily and a mine with a tonnage developed capable of sustaining operations at the rate of 150 to 200 tons daily for the next four or five years.

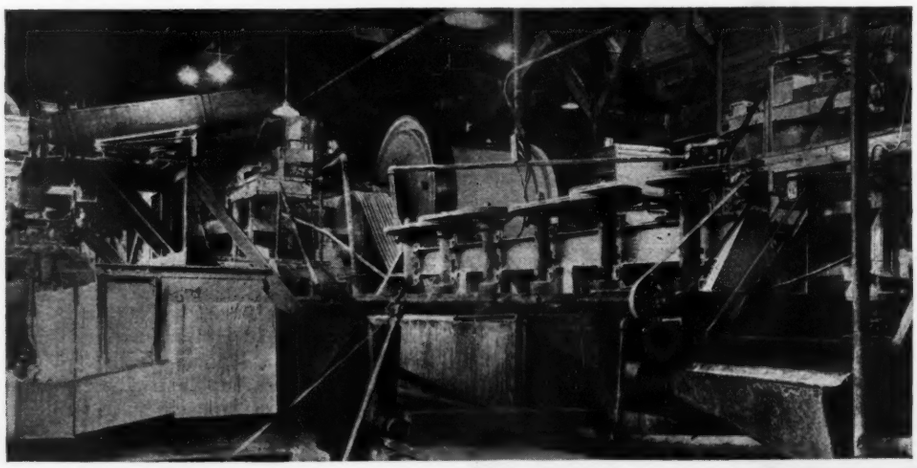
Operation of the flotation plant over a period of nine months is reported by the management as being eminently satisfactory. Started in October, 1935, the mill was operated exclusively for the first four months on dump ores. During May, a total of 5,718 tons was treated. Profits from treatment of the dump ore have averaged $5,000 a month. The company plans to start running the mill on straight mine ore, by which change, it is believed, the profit can be increased to a volume ranging from $10,000 to $20,000 a month.

Ore from the old dumps is loaded into International trucks by a ¾-yd. diesel shovel and delivered to the mill at a cost of 50c. a ton. A 170-ton bin receives it. After being fed through a 20x12-in. Farrell-Blake-type crusher, the talcy or slimy ore from the mine will be passed by a 16-in. belt conveyor to a 54x20-in. Akins classifier. The non-talcy ore goes directly on a cross-conveyor to Traylor 36x68-in. vibrating screens in closed circuit with a 3-ft. Symons cone crusher.

Eimco-Ferris flotation machines, which in two months have demonstrated certain advantages, are used in conjunction Denver Sub A cells. The Eimco-Ferris cell has the advantage of allowing control of the depth of froth without changing the pulp or water level. Reagents used are soda ash, xanthates, and pine oil. Either sulphide or oxidized ores can be treated equally well, it is said.

Employing eleven men, the company has treated 287 tons of ore in 24 hours. Recovery averages around 92 per cent. Ratio of concentration of the dump ore is 200 to 1 and that of mine ore, 250 to 300 to 1. Concentrate averages in grade 20 to 25 oz. of gold and 350 oz. of silver to the ton. Trucks of the company haul the concentrate direct to the smelter of the American Smelting & Refining Company, which is situated at Garfield, Utah.

Earl B. Young is president of the company as well as mine superintendent and geologist; William Franklin, superintendent of the mill; Joseph Rosenblatt, of Salt Lake City, is general manager; and Morris Rosenblatt is vice-president.



INTERIOR of the 250-ton flotation plant. It is equipped with Eimco-Ferris and Denver Sub A cells. Started in October, 1935, and operated at first on dump ores only, it is now handling mine ores also

ELKORO MINE AND MILL at Jarbidge, Nev. Up to 1931 it had produced a total of $6,800,000 in metal, in round figures. Shut down in September, 1932, the property was reopened two years ago and is now repaying the owners for their venture

On Mapping Underground Geology

The author describes a method he believes to be modern practice that records helpful information for the miner

Harrison Schmitt
Consulting Mining Geologist
Hanover, New Mexico

THE unsatisfactory status of the profession of mining geology compared with established ones such as law and medicine is due partly to its newness, partly to the difficulty of valuing its successes and failures, but perhaps largely to its inadequate methods of mapping. I went through the stage of discouragement which many mining geologists have experienced, when it seemed as though geology could be of little help to the miner. My present conviction of the value of geology is the result of my having seen many orebodies discovered by pure geological method. The cynical statements so often heard, "Who ever heard of an orebody being discovered by geologists?" or "Moving dirt is the best way to hunt for ore," can be refuted by the records.

Most recent discoveries of ore by geological methods resulted from detailed studies of structural conditions, and these had detailed large-scale mapping as their base. Few recent college graduates seem to have had training in the mapping methods known to be effective. Many schools whose teaching of theory is excellent leave training in mapping to luck. The student is expected to acquire the needed skill somehow after graduation; yet it may mean his bread and butter for several years. Indeed, he may never learn to map well and therefore be ineffective in exploration.

There is marked contrast between underground and surface geological mapping. (See "Cartography for Mining Geology," *Ec. Geol.* Vol. 27, pp. 716-35, 1932, wherein I have described surface mapping.) The former is usually done under favorable conditions. Every detail of rock structure along the mine openings can be exposed, and, if necessary, the walls can be washed. The chief disadvantage compared with surface mapping is the relatively small area of rock exposed, but this is usually balanced by the greater vertical exposure of the major features of structure.

Before underground detail mapping is begun the geologist should see that the underground transit surveys are in good order and, where possible, closed. I have found instances where transit mine surveying has been done, and is being done, under lax discipline and supervision. Only one of four large mines examined belonging to different companies in a certain district had accurate underground surveys. The others had to be remapped before the geological work could begin. This situation is due partly to the custom of placing newly graduated engineers on surveying work without supervision by experienced men, partly to lax discipline, and partly to inadequate training in the mining schools. Accurate geological sections require accurate elevations, yet in many mines the elevations of survey stations are not determined at all. When the transit surveys are made the elevation of the rail below the station should be measured and recorded along with the elevation of the station itself, for the profile of the rail is the base for constructing the vertical sections.

Most mining geologists with a number of years' experience in mapping believe that all details capable of being mapped should be recorded, including those which at first appear of remote significance. They may become significant when plotted and integrated on the office maps. Details of definite value include the attitude, age, width, kind of filling, and direction of slip of faults; the attitude of shear, fractures, contacts, bedding, and schistosity; the classification of the rocks and their degree and kind of alteration. There is no place for guessing when recording such data. The map must be objective and factual. Correlation and inference, except when obvious, are subordinated until the maps are built up in their final form in the office. The best base for the field maps themselves seems to be strong, clear tracing paper cut to letter size (8½x11 in.) to conform to standard files and notebooks. (Keuffel & Esser No. 197 medium Ionic or similar paper is good.) The outline of the mine workings and the coordinate lines should be traced directly on this paper with black india ink from the master "hardy-copy" (single-mounted heavy-detail paper) composite map of the mine levels such as is standard at most mines. A maximum of detail can be plotted with a 4H pencil (4H "Koh-I-Noor" appears to be the best) on the tracing paper—and the resulting map is sufficiently waterproof under average conditions. The letter-size sheets can be carried in a spring-back letter-size aluminum notebook and this, in turn, in a large-pocketed waterproof game coat or a canvas bag, or, if the mine is extremely warm, in a pocketed skeleton vest. Fine detail should not be sketched underground with colored pencils, for the points are too soft and blunt and unless an excessively large-scale base map is used they make too wide a line. Most shades of meaning can be expressed without undue loss of time by symbols and notes written with a hard, sharp pencil. Immediately after coming out of the mine the penciled field maps should be copied with ink on the trackings of the mine levels.

When mapping a mine level the most convenient horizontal plane of reference is waist high; that is, 3 ft. above the rails. For accurate work the control map of the level should show the irregularities in the mine openings measured at the horizontal plane of reference. Points of observation should be located by measuring from the nearest survey station with a cloth tape.

In areas without local magnetic anomalies the strike and dip of structural planes are usually measured with a Brunton compass. In areas with local anomalies it may be necessary to locate

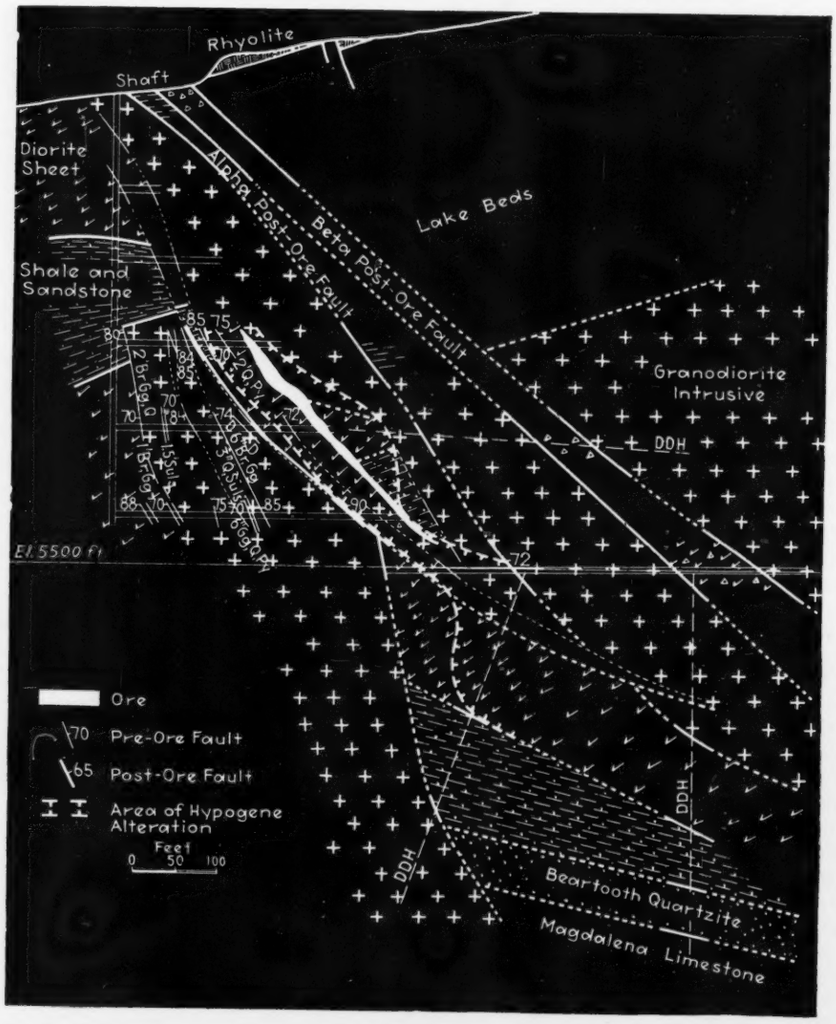
two points of equal elevation on opposite sides of the drift on the plane of mapping and to connect these with a line which is the strike. Or the angle of divergence of the strike with the center line of the drift may be determined with a compass by noting the angle of swing of the compass card around the compass needle. The method is accurate even when the needle diverges 180 deg. from the true magnetic meridian. The compass must be kept at the same point in space when turning the angle. This may be facilitated by mounting the compass on a light camera tripod and "Y" head. If possible the compass card should be graduated to read from 0 to 360 deg. Important critical dips of the vein or other structural planes may be measured accurately by holding a string or wooden straight-edge on the line of dip at the top and bottom of the drift and measuring the inclination with a Brunton. The inclination of the string, however, is best determined with a suspended inclinometer made from a protractor such as is described for use with the "string" or German compass (Fig. 4).

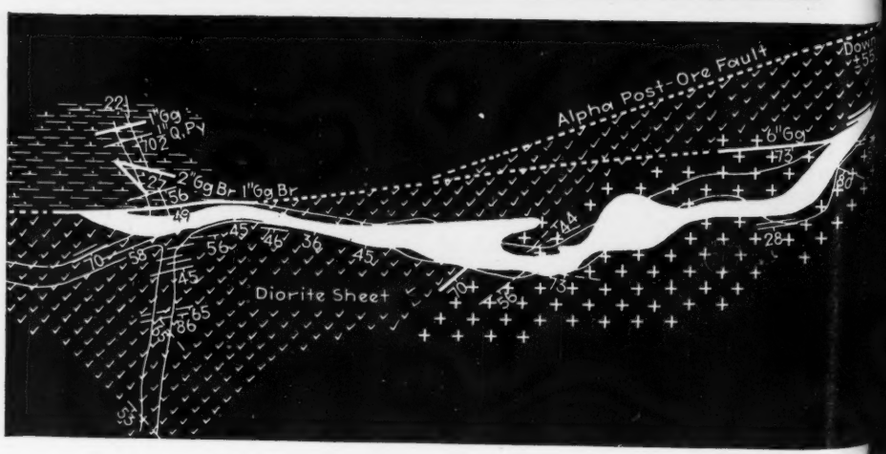
The geological mapping of underground openings which do not lie approximately on a horizontal plane—that is, stopes, raises, and winzes—is a difficult problem. Useful projections of such openings, longitudinal vertical projections along veins, and composite plans of the rooms in *blanket* deposits are often compiled by the engineers for ore-reserve estimations and other purposes and are usually available. Such projections, however, cannot be used for any but the broadest of geological interpretations, because in underground mapping, as in all geological mapping, the primary concern is with the location and attitude of planes in space and the interrelations of these planes.

Location of planes in raises, winzes, and stopes which lie between the principal levels of mapping is best done with the string compass and inclinometer. These instruments (Fig. 4) are designed for quick, accurate determination of the bearing and inclination of a cord tautly stretched between nails which represent stations of traverse. The compass frame may be made of brass sheet or other non-magnetic alloy on which is mounted a Brunton compass with the mirror and sighting bars removed. German compass equipment which may be purchased from the instrument supply houses has no provision for setting off the magnetic declination. The Brunton compass card should be graduated from 0 to 360 deg. to eliminate the possible mistake of reading the wrong quadrant.

The string compass traverse is usually started from a known transit station. Nails are driven into the walls of the opening at each turning point and a mason's cord is stretched tautly between them. The bearing is determined with the suspended compass, the inclination by two readings of the inclinometer each equidistant from the ends of the cord. The average of the two readings is the true inclination with the error from sag compensated. A clearly marked cloth tape is then stretched between the stations, the inclined distance recorded, and offsets to the walls and/or to geologic planes are measured with another tape held normal to the string as distances vertically up and down or horizontally right and left. As a point or points on the structural planes are located, the dip and strike are recorded. The traverse notes

Fig. 1. . . . GEOLOGY in relation to the shaft and mine levels is plotted on this cross-section. Faults found on the surface are projected to those found underground and their characteristics are sometimes found to be similar. The determination of the approximate outline of hypogene alterations has been made on this cross-section, which is indicated in the figure.





are calculated with a slide rule which has sine and cosine scales and the traverse is plotted as a composite plan with elevations written in at each point. When horizontal or vertical sections are passed through the area of traverse, the structural planes are projected to them and other near-by data appended. I know of no better method of recording and representing data from workings off the normal levels. In accuracy it compares favorably with mapping on the mine levels.

Where the stoping is done by square-setting, and minute detail is wanted, many geologists make geologic maps of each floor and, for filing, bind them together in their proper relative position. At the Ground Hog mine, Vanadium, N. M., it has been found that for accurate location of square-set stope detail measurement of the position of each floor with the string compass is necessary. Beautifully detailed sections can be made, of course, if a geologic map is made of each floor. Such plans and sections are useful in directing the details of stoping and in avoiding the loss of ore in the walls.

The horizontal level plan is essentially a picture of conditions actually observed and, at least in its first stages, contains a minimum of interpretation. Proportionally more interpretation is contained on vertical and horizontal sections excepting those near extensive workings. The vertical sections, when completed, are the basis for further interpretation and extrapolation to the level plans until finally the integrated set of maps gives an approach as nearly as possible to a three-dimension picture. The limit to which the interpretation and extrapolation can be advanced safely is largely a matter of general experience; partly a matter of experience with a specific area. Details of construction of sections will be described later.

Detailed level mapping of the first grade, which is detail on scales of not less than 40 ft. to the inch, is expensive and laborious work in the average mine (Fig. 2). Under many conditions such exact work is not needed, as, for example, in mines which exploit simple, unfaulted veins or where reconnaissance mapping is in order for a mine examination, or for most grades of governmental reports. In most mines, however, where formal geologic studies are being carried on to assist exploration, the highest grade of detail mapping is the only kind worth considering or which will do any good. At the very best the facts recorded will fall short of the number desired.

Usually, the primary character of the rocks and their age relationships, which include the stratigraphic succession, should be studied before formal detail mapping begins. Much of this preliminary work can be done on the surface. Additional knowledge of the rocks and their relationship will be obtained when the detailed underground mapping is carried out. The new information may upset some of the earlier concepts and make necessary a review of some of the ground already mapped. Few geologists who have mapped detail have not felt the need some time or other of remapping ground they have previously covered.

Little need be added to what has already been said about the location of geologic planes. As they are traced out I mark them by smudging with an acetylene mine lamp. They are mapped before other observations are recorded largely because many are lithologic boundaries. Further, where there is much detail, speed is gained and fewer details are missed if the work is subdivided, attention first being fixed on structure (largely planes), then lithology, then alteration and other related data.

The detailed study of faults should receive emphasis. Age classification is especially important, although often complicated by reopening from pre-mineral to post-mineral time. To fol-

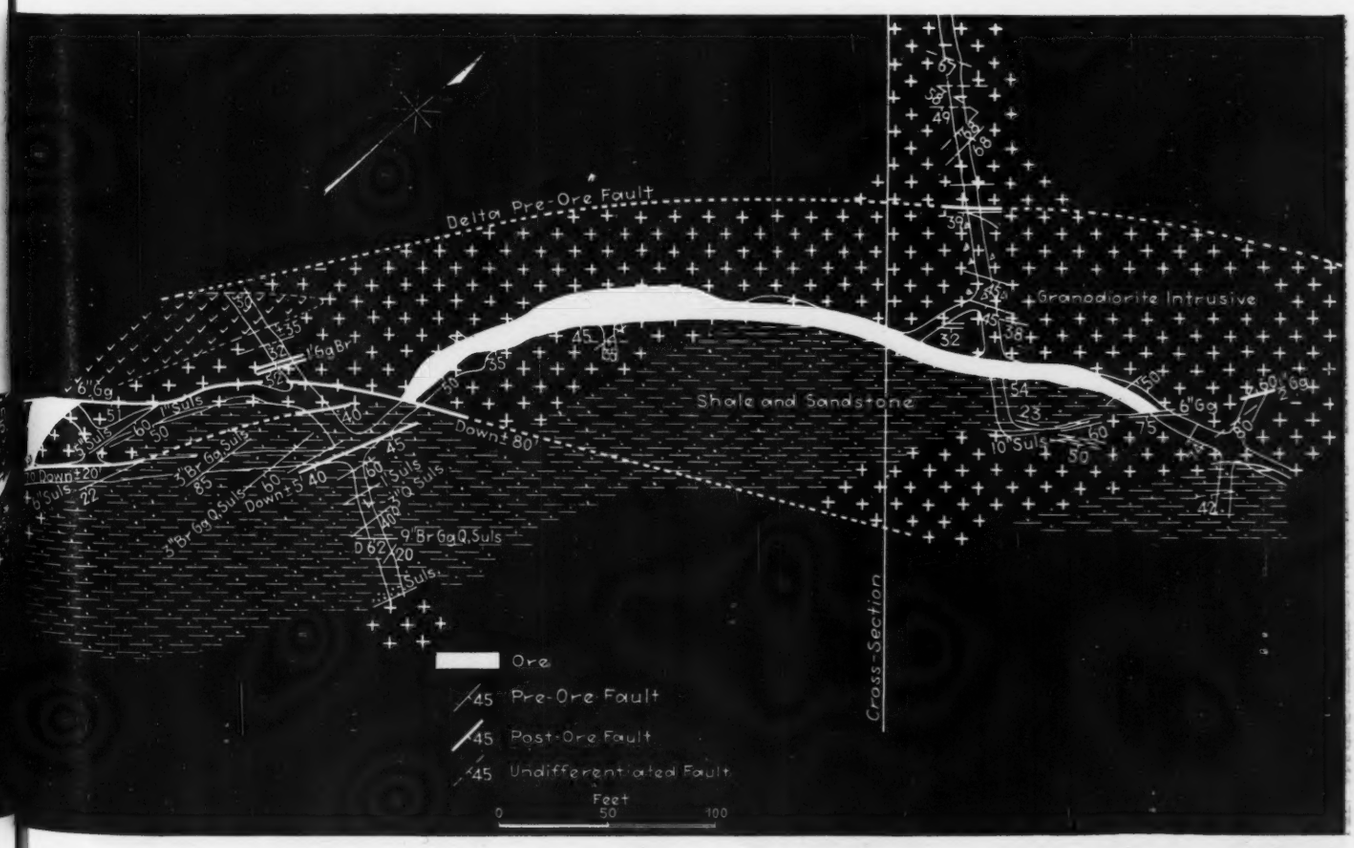


Fig. 2. . . . THE MAPPED GEOLOGY of a mine level is a picture showing rock contacts, faults, the vagaries of the ore deposit, and other important geological conditions. Study of these maps by the miner affords important data for planning development and exploitation. It also helps to construct a three-dimensional view of a deposit. Pre-ore and post-ore faults are shown and the figures indicate the dip of the faults and rock contacts. The letters indicate the minerals present and the composition of the various rocks

low ore in strongly faulted country one should know particularly two classes of structural information; first, the approximate original position and attitude of the structures which localized the ore, and, second, the position, attitude, direction of relative movement, and amount of offset of the post-mineral faults. The pre-mineral faults or fractures are usually recognized by their effect on the localization of ore, ore minerals, or gangue minerals associated with the epoch of ore deposition. Such mineralization is usually banded in or parallel to the break. If the pre-ore faults and fractures fall in a definite pattern or system, the pre-ore age of a given mineralized fault which is connected with or parallels the pattern or system may at times be inferred.

Post-ore faults within a given mineralized area may be recognized by the character of the breccia fragments, which, if the faulting is important, with the formation of thick gouge, may appear as well-rounded fragments of the harder parts of the ore or of the altered walls associated with the ore. Often such fragments are quartz. Patient digging in the gouge may be necessary to find them. The well-known criteria for post-ore faults such as the drag on the ore where cut off and small offsets of ore by minor shear planes sympathetic to the main fault should be the first evidence sought. The age of a fault may be fixed if it or its sympathetic shear planes cut veinlets of mineralization contemporaneous with the ore. The various strands, branch faults,

Fig. 3. . . . SECTION OF A FAULT showing attitude of laminations in the gouge

and sympathetic shears related to a fault are, of course, generally contemporaneous with it.

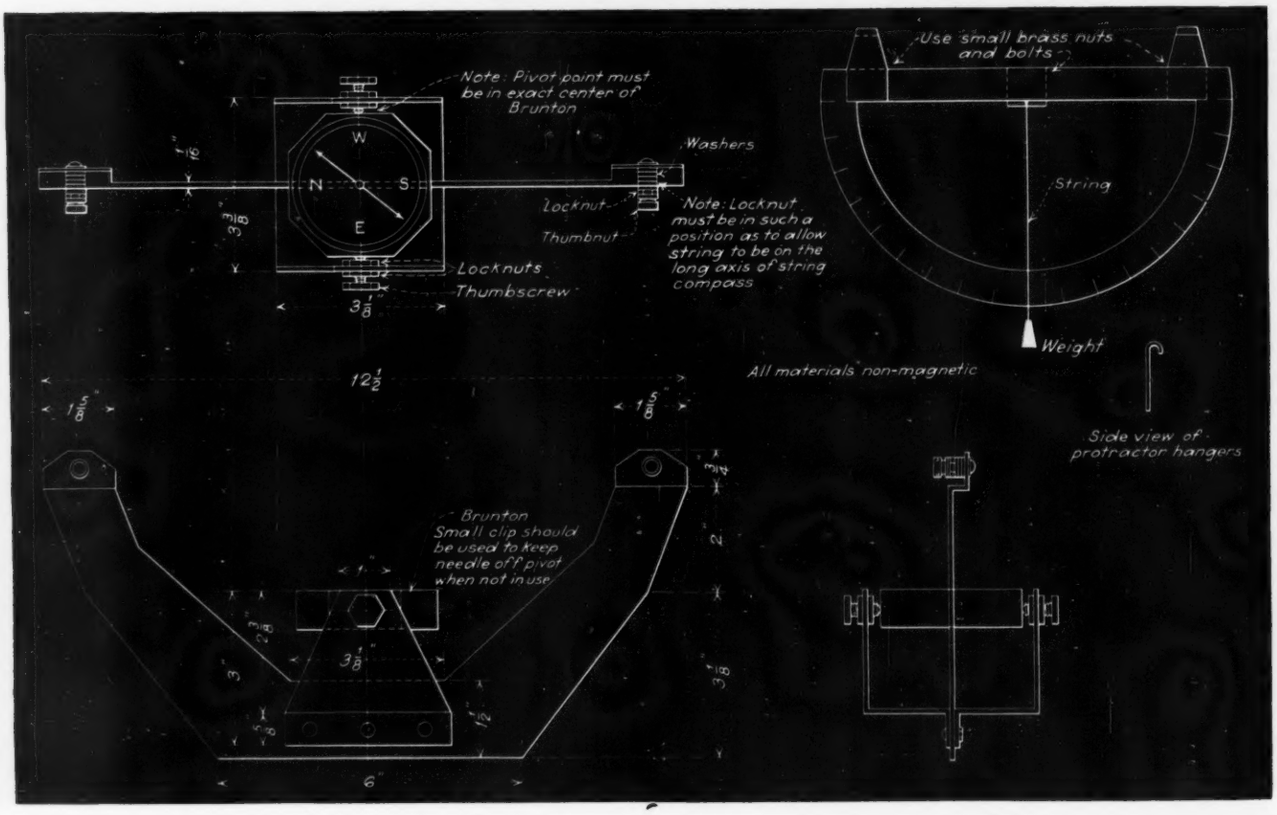
The thickness and character of the gouge or other filling in faults and veins should always be recorded. Within a given area these data are invaluable for dating, correlating, and judging the relative importance of faults and veins. The direction of the striations on many fault planes may be an unreliable criterion for the average direction of slip, because of the heterogeneity of movements which have occurred. On many faults, however, the striations are indicative of the true direction of slip and should be recorded. The direction of relative offset usually can be determined by a careful study of the attitude of the gouge laminations (Fig. 3). I have had little success with the study of chatter marks, tailing of soft material behind a hard projection, and similar criteria.

When mapping dikes, inclusions should receive particular attention. They may determine the age of the dike; for example, they may include fragments of ore, and may give information on the rocks to be expected in depth.

The importance of general studies of the wall-rock alteration cannot be overemphasized. All modern mapping should include classification as to the character and estimates as to the intensity of the alteration. Observations are usually taken at intervals of not greater than 15 to 25 ft. Hypogene and supergene alteration should be distinguished if possible. I estimate the intensity of the alteration as slight, medium, and strong—equivalent to the limits 0-33, 33-66, and 66-100 per cent.

For example, at a certain mine the symbol "Kbd-MD-ALT; Q Ch, Py" means Cretaceous "birdseye" diorite porphry moderately altered with quartz, chlorite, and pyrite as replace-

Fig. 4. . . . A DEVICE for holding a Brunton compass used in taking astromomic bearings in stope surveys can be made with the aid of these details. Small hangers on the protractor permit quick attachment to the strings run through the stopes, and the inclination is readily determined



ments whose volume importance is estimated to be in the order given.

Such data may be useful in several ways. For example, since the outline of the boundaries of the alteration along a vein is usually a magnification of the outline of the vein itself, it is possible to judge the position of exploratory drifts and crosscuts in relation to the vein even when these have only slightly penetrated the alteration zone. Further, when a drift has run out of typical wall alteration along the strike it may be useless to crosscut or continue farther for ore unless there is reason to believe one is in an intershoot block. Again, in strongly post-ore faulted country where few observations on the dip of the ore can be obtained, the outside contacts of the alteration zone, when outlined, may aid in plotting the probable attitude of the vein.

At the Pewabic mine, in the Central mining district, in New Mexico, it has been found that the pyrometasomatic silicate alteration and the sphalerite orebodies are mutually associated; that it is useless to explore for ore in the unsilicated limestone. The age classification of dikes is often facilitated by the study and classification of the alteration that has taken place.

The degree of probability of the various observations and interpretations should be estimated and expressed by quantitative symbols. I use solid lines for known contacts and dotted lines for inferred or approximately located contacts, the spacing of the dots being inversely proportional to the degree of probability. An essential of good mapping is clear differentiation between facts and inferences and an adequate representation of this differentiation on the maps.

Assembly of Field Data—The level, stope, and raise data on the letter-size field maps can be plotted on large, master office maps usually made of tracing cloth. These maps as a rule include large-scale sections and level plans on the same scale as the field maps, so the field data can be traced directly. Stope maps, stope sections, and field maps of individual raises, winzes, and small sublevels may be plotted on letter-sized tracings, which are then punched and filed in cloth-bound notebooks. Small-scale—say 100 ft. to the inch—reductions of the more important of the plans and sections will aid in the determination of relationships.

Today the emphasis is more and more turning to oreshoots, their inlets and outlets (roots and gossans), and associated alterations. Obviously, the first step in studying an oreshoot is to make an accurate representation of the known part of it. This is done with equal-ore-width or thickness lines, equal-ore-value and equal-metal-ratio lines usually projected to a longitudinal vertical projection, but if the vein is flat, to a horizontal projection or projection parallel to the plane of the vein. These projections should include the projections of the intersections of pre-mineral and post-mineral faults and veins and of the junctions of branch veins with the main vein. If the vein has been faulted, no effort should be spared to work out the amount and direction of the slip. The inferred position of the faulted segment should be plotted.

All available data from the plans and string compass notes should be plotted on the sections. The trace of the intersections of the various planes should be calculated or derived from the published charts and plotted with their proper component of dip. Correlations of geologic planes from level to level is aided by plotting the angles made by the strike of the planes with the sections and the thickness and character of the filling of the fault and veins (Fig. 2). Wall-rock alteration data should, of course, be plotted on the sections as well as the plans.

The tracing cloth used for the large maps, since it shrinks rapidly for a few days after unrolling, should be cut the proper size and then stretched out and dried on a wall for several weeks before the coordinate lines are drawn on it. Colored india inks should be used for plotting the various data, and they print better if about 1 c.c. of orange ink is added to each 1 oz. bottle, especially to the green, blue, purple, brown, and carmine inks. Lines of various weights, particularly curved lines, can be drawn best in many cases with Barch-Payzant pens. Orange and yellow inks should be avoided when possible except for permanent lines such as coordinate lines, because they dissolve the starch in the cloth and are difficult to erase cleanly. Erased spots should be filled and rubbed smooth with gritless sticks of talc.

Gritless crayons are used for coloring the tracings and prints. (Dixon's and Faber's crayons are good. One set of Faber's has 60 colors.) The color should be laid on evenly and then dissolved and spread smoothly with paper stumps dipped in gasoline, or, better, xylol, which is non-inflammable, and wiped moderately dry with cloth. Surplus paint can be quickly distributed more evenly or wiped off with small wads of cloth. Before prints are made, most of the paint should be removed from the tracings with art gum.

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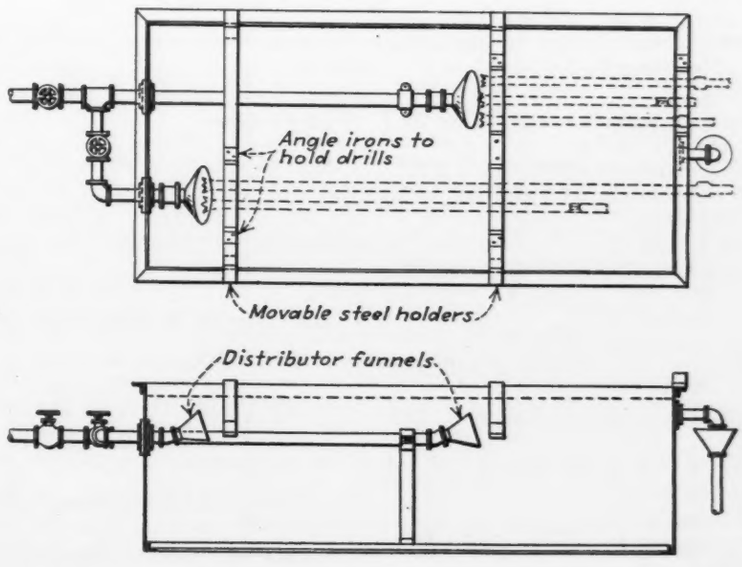
An Efficient Cooling Tank



THE NOVEL WATER TANK, the general features of which are explained in the accompanying sketch, was designed and built by F. L. Miles, shop foreman, United Verde Branch, Phelps Dodge Corporation, Jerome, Ariz., for cooling drill bits at the drill-sharpening shop. At many such shops the importance of proper cooling is not always realized, and as a consequence inferior drills are frequently sent underground despite careful heating and treatment given them in the sharpener.

The bits must be cooled rapidly and uniformly if soft surfaces or soft centers are to be avoided. To provide this requirement, all cooling tanks at the United Verde shops, including those used for cooling churn-drill bits, were fitted with distributor funnels as shown. These are arranged in a manner to facilitate separate cooling of starters, seconds, and finishers. The drills are held in place by adjustable bars traversing the tank equipped with welded-on angle irons to prevent them from falling into the tank. The tank proper is made from steel plates, welded, and braced by angle irons.

Autogenous Smelting

Of Copper Concentrates

With

Oxygen-enriched Air

• II •

T. E. Norman
580 Huron St.,
Toronto, Canada

CALCULATIONS have been made on: (1) feed containing 2% moisture; (2) feed containing 0.5% moisture. Each of these solid feeds was considered as being fed into the furnace with undiluted commercial oxygen (95% O_2 5% N_2).

Feeding was assumed to be done at: (1) 1,500 tons per day; (2) 3,000 tons per day. The more important results from each of these calculations are given in Table III.

In the following I summarize the more important details in the calculation on each of the three feeds:

1. Noranda[13]:

Dry-feed analysis, 3.82% Cu., 24.2 SiO_2, 33.6 Fe, 24.3 S.

Calcine analysis, 4.05% Cu, 11.8 S.

All sulphides in feed assumed to be FeS and Cu_2S.

2. Flin Flon[14]:

Dry-feed analysis 7.35% Cu, 4.9 Zn, 1.1 Pb, 18.4 SiO_2, 26.9 Fe, 2.0 Al_2O_3, 4.0 MgO, 1.8 CaO, 28.7 S.

Calcine analysis, 13.3% S.

Calcine weight = 91% of weight of feed.

Assume sulphides are FeS, FeS_2, ZnS and Cu_2S.

Assume 44% of zinc stays as ZnS and enters matte.

3. Anaconda[3]:

Dry-feed analysis, 27.0% Cu, 7.1 SiO_2, 30.8 Fe, 31.5 S.

Calcine analysis, 19.5% S.

Assume calcine = 96% of weight of feed.

Assume sulphides are FeS, FeS_2, and Cu_2S.

Sample Calculation on Noranda Feed

Feed and calcine analyses as given.

Moisture in feed = 2.0% of dry weight of feed.

Assume all oxidized Fe is as Fe_3O_4.

Operation 1. Take 100 kg. of feed.

$$\text{Weight of calcine} = \frac{3.82}{4.05} \times 100 = 94.4 \text{ kg.}$$

In calcine:

$$\text{S with Cu as } Cu_2S = \frac{3.82}{127} \times 32$$

$$= 0.96 \text{ kg. of S as } Cu_2S$$

$$\text{S with Fe as FeS} = (11.8)(.944) - .96$$

$$= 10.14 \text{ kg. of S as FeS}$$

$$\text{Hence, Fe as FeS} = \frac{10.14}{32} \times 56$$

$$= 17.75 \text{ kg. of Fe as FeS}$$

$$\text{Fe as } Fe_3O_4 = 33.6 - 17.75$$

$$= 15.85 \text{ kg. of Fe as } Fe_3O_4$$

$$\text{S burned to } SO_2 = 24.3 - 11.1$$

$$= 13.20 \text{ kg. of S as } SO_2$$

$$\text{Volume of } SO_2 \text{ formed} = \frac{13.2}{32} \times 22.4$$

$$= 9.25 \text{ cu.m at N.T.P.}$$

Oxygen required:

$$\text{For } Fe_3O_4 = \frac{15.8}{168} \times 64$$

$$= 6.04 \text{ kg.}$$

$$\text{For } SO_2 = \frac{13.20}{32} \times 32$$

$$= 13.20 \text{ kg.}$$

$$\text{Add 0.52 cu.m. of } O_2 \text{ in exit gas} = \frac{0.52}{22.4} \times 32 = 0.74 \text{ kg.}$$

Total O_2 required
= 19.98 kg.
= 14.0 cu.m. of O_2 at N.T.P.

$$N_2 \text{ accompanying} = \frac{5}{95} \times 14.0 = 0.74 \text{ cu.m. of } N_2$$

Oxygen required per ton of solid feed
= 0.1998 tons of O_2

Analysis of gas in flame:

SO_2 =	9.25 cu.m. =	71.11% by volume
O_2 =	0.52 cu.m. =	4.00% by volume
N_2 =	0.74 cu.m. =	5.69% by volume
H_2O =	2.49 cu.m. =	19.20% by volume
Total	13.00 cu.m. =	100.00%

Heat of reaction:
Heat of formation of products of combustion
15.85kg. of Fe as Fe_3O_4 @ 1,588
= 25,200 cal.
17.75 kg. of Fe as FeS @ 413
= 7,350 cal.
13.2 kg. of S as SO_2 @ 2,160
= 28,500 cal.
Total = 61,050 cal.

Heat of formation of active components before reaction:
33.6 Fe as FeS @ 413
= 13,900 cal.
Heat of reaction
= 47,150 cal.
Heat required to vaporize $H_2O = 2 \times 600$
= 1,200 cal.
Heat available to raise temperature
= 45,950 cal.
Average heat capacity of products: (Assume final temp. = 1,500 °C.)
27.9 kg. of FeS @ 0.213 = 5.95 cal./°C
4.8 kg. of Cu_2S @ 0.154 = 0.74 cal./°C
} Includesheat of fusion
61.7 kg. of oxides @ 0.26
= 16.00 cal./°C.
Total for solids
= 22.69 cal./°C.
9.25 cu.m. of SO_2 @ 0.529
= 4.90 cal./°C.
1.26 cu.m. of $N_2 + O_2$ @ 0.339
= 0.43 cal./°C.
2.49 cu.m. of H_2O @ 0.565
= 1.41 cal./°C.
Total for gases
= 6.74 cal./°C.
Total for all products
= 29.43 cal./°C.
Maximum theoretical flame temperature

$$= \frac{45{,}950}{29.43} = 1{,}560°\text{C.}$$

Operation 2

Correction for radiation & conduction of heat = 8,330 cal. per 100 kg. (@ 1,500-ton rate)
Heat available
= 45,950 — 8,330 = 37,620 cal.
Theoretical temperature rise after correction

$$= \frac{37{,}620}{29}$$

= 1,300°C. (approx.)
In actual practise the temperature of the flame and of the calcine falling on the hearth should be somewhere between 1,560°C. and 1,300°C.

Operation 3:

Sensible heat in material falling on hearth

$$= \frac{(22.69)}{(29.43)}(37{,}620)$$

= 28,950 cal.

Heat of reactions:

$3\ Fe_3O_4 + FeS = 10\ FeO + SO_2$

ΔH 1,300 deg. C = +76,300 cal. (endothermic)

$10\ FeO + 10\ SiO_2 = 10\ FeO\ SiO_2$

ΔH 1,300 deg. C = —59,000 cal. (exothermic)

Hence, $3\ Fe_3O_4 + FeS + 10\ SiO_2 = 10\ FeO\ SiO_2 + SO_2$

ΔH 1,300°C = +17,300 cal. (endothermic)

Heat absorbed per unit of Fe as Fe_3O_4

$$= \frac{17,300}{503}$$

= 34.4 cal. per unit Fe as Fe_3O_4

Hence, heat taken from hearth material by endothermic reaction = (15.85)(34.4) = 546 cal.

Sensible heat in material after reaction = 28,400 cal.

Operation 4:

Assume only FeS and Cu_2S in matte and all oxides in slag

503 Fe as Fe_3O_4 oxidize 87.8 units of FeS

Hence, 15.85 Fe as Fe_3O_4 oxidize $\frac{15.85}{503} \times 87.8$ = 2.76 kg. of FeS

Wt. of SO_2 eliminated in operation 3

$$= \frac{15.85}{503} \times 64 = 2.02 \text{ kg. of } SO_2$$

= 0.71 cu.m.

Wt. of material on hearth = 94.4 — 2.0 = 92.4 kg.

Wt. of matte = FeS + Cu_2S — FeS oxidized = 27.9 + 4.8 — 2.76 = 29.9 kg. of matte

Wt. of slag = 92.4 — 29.9 = 62.5 kg. of slag

Heat carried off by SO_2 eliminated in Operation 3 = 0.71 × 0.515 × 1,250 = 457 cal.

Heat in material on hearth = 28,400 —460 = 27,940 cal.

Heat in matte at 1,200°C. = 29.9 × 230 = 6,880 cal.

Heat in slag at 1,200°C. = 62.5 × 330 = 20,600 cal.

Total heat in matte and slag at 1,200°C. = 27,480 cal.

Heat available to raise temperature above 1,200°C. = 460 cal.

Heat capacity of matte = 29.9 × 0.17 = 5.10 cal./°C.

Heat capacity of slag = 62.5 × 0.30 = 18.75 cal./°C.

Total = 23.85 cal./°C.

Temperature rise above 1,200°C.

$$= \frac{460}{23.85} = 19°C.$$

Hence, final temperature of matte and slag as tapped = 1,220°C.

Discussion of Calculation

The foregoing calculation indicates that molten matte and slag can be made under the conditions imposed in the problem, but that there is not much heat to spare over that required.

The presence of moisture in the feed causes consumption of a considerable amount of heat which might otherwise be doing useful work. This moisture absorbs a total of 3,400 cal. If the moisture content of the feed were reduced to 0.5 per cent there would be an additional

$$\frac{1.5}{2.0} \times 3,400 \times \frac{22}{29} = 1,930 \text{ cal. available}$$

for heating matte and slag and this would raise their final temperature an extra 90°C.

Another place where heat might be saved is from losses by radiation and conduction, by smelting at a higher rate. Since molten matte and slag should be formed as fast as the partly fused calcine settles on the hearth, the limiting factor in the rate of smelting appears to be the velocity of gases in the furnace. For Noranda material there has been made a total gas volume of 13.71 cu.m. (measured at N.T.P.) per 100 kg. of feed. In normal coal smelting of hot calcines 100 kg. of roaster feed would require about 11 kg. of coal for smelting, which would produce, for an average coal, about 82 cu.m. of gas (at N.T.P.) when no excess air was used in burning.

If it be assumed that a reverberatory furnace smelts 1,200 tons of feed per day either by pulverized coal or by oxygen, then the ratio:

$$\frac{\text{Gas velocity when smelting with pulverized coal at 1,200 tons per day}}{\text{Gas velocity when smelting autogenously at 1,200 tons per day}} = \frac{82}{13.7} = 6$$

If now the tonnage of autogenously smelted material is raised to the 3,000 ton rate, then the ratio:

$$\frac{\text{Gas velocity when smelting with pulverized coal at 1,200 tons per day}}{\text{Gas velocity when smelting autogenously at 3,000 tons per day}} = \frac{82}{34.1} = \frac{2.4}{1}$$

The foregoing ratios assume that the gases in the smelting chamber are at the same temperature in each type of smelting. This is approximately true.

Even with a 3,000-ton smelting rate, good settling of the partly fused mineral particles should be achieved and little flue dust should be made. The agglomeration of the fused mineral particles as noted by Freeman should be much more pronounced in autogenous smelting with oxygen, due to the higher ratio of solids to gas.

With the furnace fed at 3,000 tons per day the heat loss due to radiation and conduction should drop from 8,330 cal. /100 kg. of feed to about 4,200 cal./100 kg. of feed. The saving in heat carried through to the final matte and slag should be $\frac{22}{29} \times 4,130$ cal. = 3,140 cal. This should raise their final temperature an additional 132°C. If the advantages of both low moisture and high capacity are combined, a final matte and slag temperature of 1,220 + 90 + 130 = 1,440°C., would be obtained, which is well in excess of the temperature desired. This additional heat would, however, be very useful if the furnace were required to take a large amount of cool but liquid converter slag. It would also save the necessity of using pulverized coal to bring the furnace up to operating temperature after short shutdowns.

One should note that the effect of return molten converter slag has been neglected in all the heat balances made for this article. Inasmuch as the converter slag is normally near the same temperature as the tapped furnace slag, and the heat absorbed by endothermic reaction of introduced magnetite is small, the cooling effect of the converter slag on the furnace charge should not be serious.

Note should also be taken that there might be a difference in the character of the pyrrhotite fed flame and a chalcopyrite fed flame. A material high in "free atom" sulphur would probably give slightly better depletion of the oxygen in the exit gas. For all feeds, however, the flame will probably be of the short intense type capable of producing an exit gas very low in oxygen. The gas SO_2 is very stable and there is no appreciable tendency for it to dissociate into S and O_2 at any temperature attainable in autogenous smelting of copper concentrates.

The Shaft-Type Combustion Chamber. —This type was used both in the Freeman pyrite burner and in the Anaconda shaft roaster. Laist and Cooper[3] state that their shaft roaster had a capacity of 4.5 to 5 tons per day per square foot of cross-section in a shaft having an effective height of not more than 20 ft. The capacity evidently varies inversely as the volume of gas which must pass through the chamber per unit of solid feed. Inasmuch as considerably less gas is generated per unit of feed when roasting with 95% oxygen than is generated with ordinary air, therefore the roasting capacity of the shaft should increase proportionately. In the test at Anaconda approximately 110 cu.m. of gas measured at N.T.P. was passing through the shaft per 100 kg. of solid feed. In the calculations made for this article, when roasting with 95% oxygen the amount of gas produced per 100 kg. of feed varied from 10 to 16 cu.m. Taking the 16 cu.m. figure and changing its volume to that which it occupies at 1,900° absolute, and comparing it to 110 cu.m. changed to 1,100° absolute, the ratio becomes:

$$\frac{\text{Shaft capacity when using 95 per cent oxygen}}{\text{Shaft capacity when using air}} = \frac{(110)\ (1100)}{(16)\ (1900)} = \frac{4}{1}$$

The shaft capacity is therefore about 4.5 × 4 = 18 tons per sq.ft. per day. A shaft of 1,000 tons' daily capacity would require an effective area of 55.5 sq.ft. A circular shaft with an inside diameter of 8.5 ft. would fill this requirement.

The heat loss by radiation and conduction from the shaft walls should not be more than 2,000 B.t.u. per hour per square foot of outside area. The total area of a shaft 25 ft. high is about $(10.5 \times \pi \times 25) + 111 = 936$ sq.ft. From such a shaft the heat loss works out to be 45 million B.t.u. per day, which amounts to 1,250 cal./100 kg. of feed when feeding at the 1,000 ton per day rate. This figure was used in the thermal balances made on autogenous smelting in the shaft chamber.

Summary of Thermal Balances Made on Autogenous Smelting in a Shaft Chamber.—Thermal balances were made on the Noranda, Flin Flon, and Anaconda feeds assuming the feed rate in a shaft 8.5 ft. in diameter and 25 ft. high was 1,000 tons a day using 95% oxygen.

Balances were made on: (1) feed containing 2% moisture; (2) feed containing 0.5% moisture.

The effect of diluting the commercial oxygen with air was studied by assuming two parts of commercial oxygen were mixed with one part of atmospheric oxygen and the mixture was fed with solid feed at the rate of 500 tons per day. This decrease in feed rate is necessary, due to the higher ratio of exit gas to solid feed when using diluted oxygen.

Balances were made as before on: (1) feed containing 2% moisture; (2) feed containing 0.5% moisture.

The grade of feed and degree of desulphurization were assumed in all the balances noted in the foregoing to be the same as given for the thermal balances on the reverberatory smelting chamber. The more important results from these calculations are given in Table III.

Sample Calculation on Shaft Smelting Using Noranda Feed

The feed and calcine analysis assumed to be the same as in reverberatory smelting. For 2% moisture in feed, per 100 kg. of feed:

(a) Using 95% oxygen:

Heat available to raise temperature
= 45,950 cal.

Heat capacity of products
= 29.43 cal./°C.

$$\text{Max. theoretical flame temp.} = \frac{45{,}950}{29.43}$$
= 1,560°C.

Heat in products after correction for radiation
= 45,950 — 1,250
= 44,700 cal.

Heat in solid and liquid material
$$= \frac{22.7}{29.4} \times 44{,}700$$
= 34,500 cal.

Endothermic heat of hearth reaction
= 546 cal.

Heat in SO_2 elminated in reaction
= 0.71 × 0.529 × 1,500
= 564 cal.

Total heat eliminated from hearth
= 1,110 cal.

Heat available for matte and slag
= 33,400 cal.

Heat in matte and slag at 1,200°C.
= 27,480 cal.

Heat available to raise matte and slag temp. above 1,200°C.
= 5,920 cal.

$$\text{Temperature rise above 1,200°C.} = \frac{5{,}920}{23.85}$$
= 248°C.

Final temperature of matte and slag = 1,200 + 248
= 1,448°C.

(b) Sample Calculation using ⅔ manufactured oxygen + ⅓ atmospheric oxygen. (Mixture 43.3% O_2)

Noranda feed, 2% H_2O

Roast to 4% O_2 in exit gas, making calcine as before.

Oxygen required for SO_2 and Fe_3O_4
= 19.24 kg. of O_2
= 13.5 cu.m. of O_2

$$\text{Nitrogen accompanying above} = \frac{56.7}{43.3} \times 13.5$$
= 17.7 cu.m. of N_2

SO_2 in exit gas
= 9.25 cu.m. of SO_2

$N_2 + SO_2$ no excess air
= 26.95 cu.m. of $N_2 + SO_2$

$$\text{Excess } O_2 \text{ present} = \frac{4}{100} \times 32.5$$
= 1.30 cu.m. of excess O_2

$$\text{Excess } N_2 \text{ accompanying} = \frac{56.7}{43.3} \times 1.30$$
= 1.70 cu.m. of N_2

H_2O present
= 2.49 cu.m. of H_2O

Total volume
= 32.44 cu.m. of exit gas

Heat available to raise temperature
= 45,950 cal.

Average heat capacity of products assuming final temperature:
= 1,300°C.

27.9 kg. of FeS @ 0.218
= 6.10 cal./°C.
4.8 kg. of Cu_2S @ 0.158
= 0.76 cal./°C.
} Includes heat of fusion

61.7 kg. of oxides @ 0.255
= 15.74 cal./°C.

Total for solids
= 22.60 cal./°C.

9.25 cu.m. of SO_2 @ 0.518
= 4.80 cal./°C.

20.70 cu.m. of $N_2 + O_2$ @ 0.334
= 6.92 cal./°C.

2.49 cu.m. of H_2O @ 0.535
= 1.33 cal./°C.

Total for gases
= 13.05 cal./°C.

Total for all products
= 35.65 cal./°C

$$\text{Maximum theoretical flame temp.} = \frac{45{,}950}{35.65}$$
= 1,290°C.

The capacity of the shaft will be restricted due to increased volume of gases per unit of solid feed. When 16 cu.m. of gas was made the capacity of the shaft was 1,000 tons per day. Here 32 cu.m. of gas is made, so the capacity of the shaft should be 500 tons per day and radiation loss per unit of solid feed will be doubled.

Hence, heat loss by radiation per 100 kg. of feed = 2,500 cal.

Heat available to products after correction for radiation = 45,950 — 2,500
= 43,450 cal.

$$\text{Temperature rise} = \frac{43{,}450}{35.65}$$
= 1,215°C.

Sensible heat in solid and liquid material
$$= \frac{22.6}{35.6} \times 43{,}450$$
= 27,600 cal.

Heat loss by endothermic reaction on hearth
= 546 cal.

Heat loss by SO_2 eliminated in reaction
= 0.71 × 0.51 × 1,200
= 434 cal.

Total heat eliminated from hearth
= 980 cal.

Hence, heat available for matte and slag
= 26,620 cal.

Heat in matte and slag at 1,200°C.
= 27,480 cal.

Heat available to raise temp. above 1,200°C.
= —860 cal.

Table III—Summary of Results Obtained From Thermal Balances

	Unit	Noranda 2% H_2O in Feed	Noranda 0.5% H_2O in Feed	Flin Flon 2% H_2O in Feed	Flin Flon 0.5% H_2O in Feed	Anaconda 2% H_2O in Feed	Anaconda 0.5% H_2O in Feed
Sulphur in feed	%	24.3	24.3	28.7	28.7	31.5	31.5
Sulphur in calcine (At end of Operation I)	%	11.8	11.8	13.3	13.3	19.5	19.5
(a) *Using 95% ozygen with feed.*							
Theoretical maximum flame temperature	°C.	1,560	1,650	1,560	1,650	1,345	1,435
Final temperature of matte and slag at 1,500 tons per day in a reverberatory furnace	°C	1,220	1,310	1,215	1,310	....	....
Final temperature of matte and slag at 3,000 tons per day in a reverberatory furnace	°C	1,350	1,440	1,350	1,445	1,105	1,190
Final temperature of matte and slag at 1,000 tons per day in a shaft furnace	°C.	1,450	1,525	1,440	1,525	1,215	1,305
Oxygen required per ton of feed smelted	Tons	0.200	0.200	0.222	0.222	0.173	0.173
Oxygen cost required per ton of feed @ $3.50 per ton of O_2	Cents	70.0	70.0	77.7	77.7	60.7	60.7
Volume of exit gas per 100 kg. of feed	Cu.m. at N.T.P.	13.7	11.8	16.0	14.1	13.0	11.2
(b) *Using 43.3% O_2 with feed.*							
Theoretical maximum flame temperature	°C.	1,290	1,350	1,260	1,325	1,140	1,210
Final temperature of matte and slag at 500 tons per day in shaft furnace	°C.	1,164	1,220	1,133	1,195	....	....
Manufactured oxygen required per ton of feed smelted	Tons	0.141	0.141	0.156	0.156	0.122	0.122
Oxygen cost per ton of feed smelted	Cents	49.3	49.3	54.7	54.7	42.7	42.7
Volume of exit gas per 100 kg. of feed	Cu.m.at N.T.P.	33.1	31.0	37.50	35.44	29.8	27.9

Temperature drop below 1,200°C. $= \frac{860}{23.8}$
$= 36$°C.
Final temperature of matte and slag
$= 1,200 - 36$
$= 1,164$°C.
Oxygen used in smelting $= 13.5 + 1.3$
$= 14.8$ cu.m. of O_2
$= 21.15$ kg. of O_2
Manufactured oxygen used $= 21.15 \times \frac{2}{3}$
$= 14.1$ kg. (per 100 kg. feed)
Cost of oxygen per ton of feed
$= 3.50 \times 0.141 = 49.3$c.

Summary of Results From All Thermal Balances

Table III gives a condensed summary of the results from all the heat balances made for this article.

From a study of Table III it is apparent that a dry feed is very desirable. Either a higher furnace temperature can be attained or for the same furnace temperature a substantial saving in oxygen cost may be achieved. The slight extra cost of drying from 2% moisture to 0.5% moisture would probably be far more than offset by saving in oxygen cost.

The shaft type of combustion chamber is indicated to be superior to the reverberatory furnace except possibly where the reverberatory furnace could be fed at rates of from 3,000 to 5,000 tons per day. The feeding at such tonnage rates as this would probably bring many other difficulties, especially to existing plant installations.

The leanest enriched air mixture which may be used for autogenous smelting appears to be that with about 45% oxygen content. This mixture can be used only where the degree of desulphurization is fairly high, such as on low-grade feed and where losses due to radiation, moisture and incomplete combustion are kept at a minimum.

For feed of the Anaconda type the more efficient shaft chamber appears to be a necessity if autogenous smelting is to be attained. With dry feed and a rate of 3,000 or 4,000 tons per day, the smelting might be accomplished in a reverberatory, but there would be very little heat to spare and magnetite reduction might be poor.

For material of the Noranda and Flin Flon type it appears to be necessary to dilute the oxygen feed with air; otherwise the excessively high temperatures will cause trouble, due to refractory failure.

The dilution of the oxygen might for many plants be undesirable even in the face of lowered oxygen costs, as this dilution causes lowered furnace capacity, more flue dust or flue clinker and lower SO_2 in the exit gas. Where the gas is to be re-treated for recovery of sulphur as elemental sulphur or as liquid SO_2, a high concentration of SO_2 in the gas to be treated is very desirable.

Comparison of Cost of Preheated Air to Cost of Oxygenated Air.—Autogenous smelting by burning concentrates in a reverberatory furnace with preheated air has been suggested by Krejci (United States Patent 1,915,540, June 27, 1933). The comparative advantages of preheated air against oxygen-enriched air therefore merit some consideration in this article.

Probably the simplest method of preheating is by electrical resistor elements. It may not be the cheapest method, but as the efficiency of heat exchange is practically 100% the calculation of the cost of preheating by this method may be done with fair accuracy. For preheating in the various types of heat exchangers with carbonaceous fuel, a prediction of operating costs is difficult and uncertain. Consequently, only electrical preheating will be considered here.

The following summarized calculation considers burning Noranda feed (containing 2% moisture) with atmospheric air sufficiently preheated to allow autogenous smelting to take place:

Assume sufficient preheat to bring maximum theoretical flame temperature to 1,500°C.
Feed and calcine analysis the same as in previous sample calculations.
Per 100 kg. of feed:
Air required to roast and to leave 4% O_2 in exit gas
$= 80$ cu.m. at N.T.P.
Volume of exit gases
$= 78.3$ cu.m. at N.T.P.
Average heat capacity of exit gases
$= 28.8$ cal./°C.
Total heat capacity of all products
$= 28.8 + 22.7$
$= 51.5$ cal./°C.
Heat required to raise products to 1,500°C.
$= 51.5 \times 1,500$
$= 77,300$ cal.
Heat available from burning reactions
$= 45,950$ cal.

Preheat required in air
$= 31,350$ cal.
Power required to preheat air $= \frac{31,350}{865}$
$= 36.2$ kw.-hr.
Power required per ton of feed
$= \frac{2,000}{220.5} \times 36.2$
$= 329$ kw.-hr.
Cost of power per ton of feed at ½c./kw.-hr.
$= 329 \times \frac{1}{2}$
$= \$1.65$
Heat capacity of preheated air (80 cu.m.)
$= 80 \times 0.332$
$= 26.56$ cal./°C.
Temperature of preheated air $= \frac{31,350}{26.56}$
$= 1,180$°C.

This calculation indicates that the cost of preheating electrically is more than double the cost of autogenous smelting with oxygen-enriched air. The important advantages of low gas-solid ratios and high concentration of SO_2 in the exit gas, which result from oxygen smelting, are not obtained with air preheating. Also, the calculation indicates that the air must be preheated to an excessively high temperature.

The combination of electrical preheating in conjunction with oxygen-enriched air is a process which might be applied. The following calculation considers burning Noranda feed (2% H_2O) with 43.4% oxygenated air and adding sufficient preheat to raise the final temperature of matte and slag from 1,164°C. to 1,450°C. This amount of preheat is equivalent to increasing the oxygen content of the air feed from 43.3 to 95%. (See Table III.)

Per 100 kg. of solid feed:
Extra heat required in matte and slag
$= 286 \times 23.8$
$= 6,800$ cal.
This requires an extra heat in all products of
$(6,800)\left(\frac{35.6}{22.6}\right)$
$= 10,700$ cal.
This 10,700 calories must be supplied by preheat in air
Power required $= \frac{10,700}{865}$
$= 12.4$ kw.-hr.
Power required per ton of feed $= \frac{2,000}{220.5} \times 12.4$
$= 112.5$ kw.-hr.
Cost of power per ton of feed @ ½c./kw.-hr.
$= 56.3$c.
Cost of obtaining same increase in temperature with oxygen $= 70 - 49.3$
$= 20.7$c.
Air (43.3% O_2) used in burning
$= 34.2$ cu.m.
Heat capacity of this enriched air
$= 34.2 \times 0.327$
$= 11.2$ cal./°C.
Temp. of preheated air $= \frac{10,700}{11.2}$
$= 955$ °C.

This calculation indicates that it is considerably cheaper to raise the furnace temperature by increasing the oxygen content of the air than by preheating the air electrically. For a number of reasons the use of stoves fired with carbonaceous fuels would not be desirable in a copper smelter. The use of air preheating does not, therefore, appear to be economically justified at any time.

Counterflow of Gases to Solids.—In all the preceding calculations I have assumed that the solids in suspension traveled in the same direction as the flow of gas. If the burning is done in a reverberatory type of furnace, no other way is possible. If, however, the burning is done in a shaft chamber it might be possible under certain conditions to have the oxygenated air introduced near the bottom of the shaft and to take off the exit gases at the top. A part or all of the feed could be introduced at the top of the shaft and allowed to drop through the hot upcoming gas and finally react with the oxygenated air being introduced above the hearth. The solids would extract a large part of the heat from the exist gas and very high hearth temperatures would be attainable, or for a constant hearth temperature a considerable decrease in the amount of oxygen enrichment would result.

From a thermal point of view the operation outlined in the foregoing would be similar to pyritic smelting in a blast furnace. From an operating point of view, however, the fact that the downcoming solids would be in the form of

small particles instead of lumps makes a very great difference. Thermal calculations indicate that molten matte and slag could be made by this method when using atmospheric air. With atmospheric air, however, the volume of the resulting exit gas would be about eight times the volume resulting when 95% oxygen is used and about three times the volume resulting when 43% oxygen is used.

The high ratio of gas to solids when using non-enriched air would mean that, for a constant rate of solid feed, a shaft of large cross area would be necessary in order that the upward velocity of the gases would not be too great to prevent proper downflow of solids. Also, the shaft would have to be much higher in order to allow the downcoming solids sufficient opportunity to "wash" the heat out of the large volume of gas. Heat losses by radiation and conduction would increase in proportion to increased wall area of the shaft. Also, the larger ratio of gas to solids might result in less complete utilization of the oxygen introduced through the tuyeres.

Apparently, then, the possibility of the utilization of the principle of counterflow in the shaft combustion chamber is much more feasible when oxygen-enriched air is used than when atmospheric air is used. The very high temperatures attained on and above the hearth would necessitate the use of the steel water-jacket type of lining, with its high heat conductivity, but the large tonnage of material smelted per unit of lining area should prevent excessive radiation and conduction loss per unit of solid feed.

A number of difficulties might be encountered in attempting this type of smelting. The exit gases would carry off with them a large amount of the finer material in the charge. One way to overcome this difficulty might be to separate this finer material from the exit gases by centrifugal type separators and then inject it with oxygen-enriched air at the tuyeres.

Another difficulty might arise due to rapid encrustation of the walls of the chamber at the zone in the shaft where the temperature is in the range of the incipient fusion temperatures of the material in the charge. This should not, however, be insurmountable.

A more serious difficulty is to be considered which might make the use of the counterflow principle impossible. In pyritic smelting the zone of highest temperature is continually moving up and down in the furnace. A similar movement of the zone of reaction in the shaft combustion chamber would probably occur, only in this case the movement might occur so rapidly that explosive waves would be generated which might render operation of the furnace impossible. Irregularities in the rate of feed of either the solids or the oxygen would aggravate this condition. In the extreme case where the solid feed was shut off completely for a minute or two, thus allowing the chamber to fill with oxygen, a serious explosion might occur when the feed was turned on again. This danger could possibly be avoided by having a small oil flame playing on the feed as it entered the chamber, thus causing immediate ignition of the feed should any oxygen be present, with the result that a slow wave of flame would be carried down the shaft as the feed descended instead of an explosive wave traveling up the shaft after the feed had descended to the point where it would be ignited by the hot walls of the furnace.

The danger of explosions seems to be so serious that the use of the principle of counterflow does not appear to be particularly encouraging. The thermal advantages to be gained by its use are very considerable, however, so the method should not be condemned without a proper trial. It is quite possible that a technique could be developed which would make it practically impossible for an explosion to occur.

Autogenous Smelting Versus Present Smelting Practice.—The study which has been made of the various phases of autogenous smelting has indicated that it should be possible to apply the process successfully to the smelting of copper and copper-nickel concentrates as obtained from sulphide ores. Certain advantages are indicated, some of which may be classed as definite and others as possible. A summary of what are probably the more important advantages is as follows:

1. *Elimination of Roasters.*—This is a definite advantage, particularly on new plant installations, as a heavy capital expenditure is avoided. This advantage is offset in part by the necessity of using dryers and a ball mill for repulverizing the dried concentrate, but the cost of this step should be considerably lower than the cost of roasting. This is especially true if the cost of handling and treating the large volume of dusty flue gases from roasting is considered as part of the roasting cost. Unfortunately, no data on actual roasting costs have been found, and actual figures therefore cannot be quoted.

2. *Space Requirements and Capacity.*—Space requirements per unit of capacity should be considerably less for autogenous smelting. For existing plants equipped for normal reverberatory smelting the possibility of a substantial increase in capacity is indicated, merely by adapting the reverberatory furnace chamber to autogenous smelting or by burning the concentrate in a shaft placed above and discharging into the reverberatory.

3. *Flexibility of Operation.*—This is indicated as being fairly definitely assured. It appears that the operator should have definite control at all times over the furnace temperature and over the degree of desulphurization achieved during roasting.

4. *High Percentage of SO_2 in the Exit Gases.*—This should be an advantage at most plants and particularly so where there is a market for liquid SO_2 or elemental sulphur. The recovery of elemental sulphur from SO_2 bearing smelter gases is much easier and much less costly where the concentration of SO_2 is high and the concentration of O_2 is low. This is the type of gas which would be obtained from all autogenous-smelting operations, and many plants should be able to obtain substantial profits from treatment of their exit gases.

5. *Fuel Costs.*—Fuel costs for autogenous smelting (considering oxygen as a fuel) are generally lower than for pulverized-coal smelting. If it is assumed that pulverized coal as fired costs $7 per ton, then with a roaster feed to fuel ratio of 9 to 1 the cost of fuel is 78c. per ton of solid feed. This is greater than any of the costs given in Table III for autogenous smelting. At some plants it may be possible to credit the waste-heat boilers with a heat recovery equivalent to about 40% of the fuel cost. The charge against coal for smelting would then be reduced to 47c. per ton of solid feed. This is probably a somewhat lower cost than can be achieved by autogenous smelting. This difference of a few cents in favor of the pulverized coal would probably be canceled when other reverberatory operating costs are considered. For coal smelting there appears to be a rather heavy and unavoidable roof renewal cost. This would be eliminated if the shaft type of autogenous smelting chamber were used.

One should remember that if pulverized-coal firing is to receive waste-heat boiler credits then autogenous smelting should also receive its due credit. Autogenous smelting produces less gas per unit of solid feed, but its heat capacity per unit volume is greater. If it is assumed in coal smelting that, per 100 kg. of solid feed, 82 cu.m. of reverberatory uptake gas enter the boiler at 1,100°C. and leave at 300°C., and in autogenous smelting 13.7 cu.m. (see sample calculation on Noranda) enter and leave the boiler at 1,100°C. and 300°C. respectively, then the ratio:

$$\frac{\text{Available heat in gas from coal combustion}}{\text{Available heat in gas from autogenous smelting}} = \frac{4.47}{1}$$

If autogenous smelting is done with 43.3% oxygenated air, the volume of 13.71 cu.m. is increased to 33.1 cu.m. Assuming the same inlet and exit temperatures as before, the ratio given above becomes 2.32 to 1. If a ratio of 3.5 to 1 is assumed as an average operating figure, then when the waste-heat boiler is credited with a recovery of 31c., (40% of the cost of the pulverized coal) it must also be credited with a recovery of 9c. worth of heat from

autogenous smelting. This saving brings the cost of autogenous smelting down to a point which can be surpassed only by the best possible conditions of coal smelting.

6. *Slag Losses.*—Losses of copper or nickel in slags generally form an important item in a smelter cost balance. A prediction of slag loses in autogenous smelting is at the best only a guess. However, inasmuch as high temperature slags appear to be possible one might find that a very clean slag might be made. On the other hand, it might be found that due to the finely divided nature of the suspension roasted feed, a rather dirty slag might be made. Probably this important question can be answered definitely only after a number of commercial-size installations had been put into operation.

A disadvantage of autogenous smelting is that trouble may be experienced from some of the semi-fused suspended material being carried into the flue, where it would settle out to form a clinker. If, however, proper provision is made for handling this material, the difficulty should be one of minor importance.

Conclusion

I can make no claim that the calculated results given in this article are an absolutely true indication of the results which would be achieved by actual experiment. I have attempted, however, to use the most reliable data available in making all calculations. In addition, I have tried to maintain an unbiased attitude in all cases where the choice of data or the method of calculation was a matter of personal judgment. I submit, therefore, that the results of the study should be a fair and reasonable indication of those which may be obtained by actual experiment.

The figures presented indicate that autogenous smelting by means of oxygen-enriched air has interesting and rather attractive possibilities. Some of the advantages to be gained by its use have been discussed. In addition, its experimental development should provide information valuable to a field of metallurgy which appears to be growing in importance—namely, the art of treating finely divided solids in gaseous suspensions. The process should, therefore, be worthy of a number of thorough and careful trials in various types of experimental units.

Bibliography

[1]Theodore Nagel. *Mining and Metallurgy*, Vol. 16 No. 34, May, 1935: "Low-cost Oxygen for Metallurgical Operations."

[2]Horace Freeman. C.I.M.M. *Bulletin*, March, 1930: "Pyrite in Pulp and Acid Manufacture."

[3]Frederick Laist and J. P. Cooper. *Trans.* A.I.M.E. 1933, Copper Metallurgy Volume. "An Experimental Combination of Shaft Roasting and Reverberatory Smelting."

[4]K. K. Kelley. U. S. Bureau of Mines Bull. 371 (1934): "High Temperautre Specific-Heat Equations for Inorganic Substances."

[5]E. D. Eastman. U. S. Bureau of Mines Tech. Paper 445 (1929); "Specific Heats of Gases at High Temperatures."

[6]Frederick Laist. *Trans.* A.I.M.E. 1933, Copper Metallurgy Volume. "History of Reverberatory Smelting in Montana."

[7]J. W. Richards. "Metallurgical Calculations," Part I.

[8]Allison Butts. "A Textbook of Metallurgical Problems."

[9]*Trans.* A.I.M.E. 1933. Copper Metallurgy Volume.

[10]U. S. Bureau of Mines Bull. 296 (1928); "Iron Oxide Reduction Equilibria."

[11]F. G. Hawley. *E. & M. J.*, April 13, 1931: "Magnetite in Copper Matte."

[12]A. C. Halferdahl. *Industrial and Engineering Chemistry*, Sept. 1930: "Reactions Between Iron Sulphide, Sulphur Dioxide, and Iron Oxides in the Metallurgy of Copper."

[13]W. B. Boggs and J. N. Anderson. *Trans.* A.I.M.E. 1933. Copper Metallurgy Volume: "The Noranda Smelter."

[14]J. H. Ambrose: *Bulletin* C.I.M.M. Sept. 1935: "The Flin Flon Copper Smelter."

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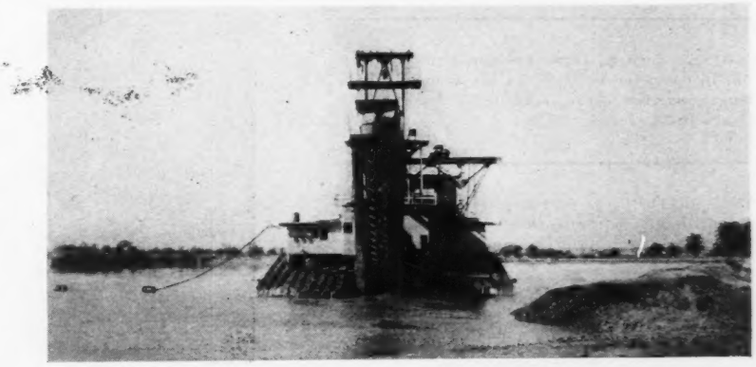
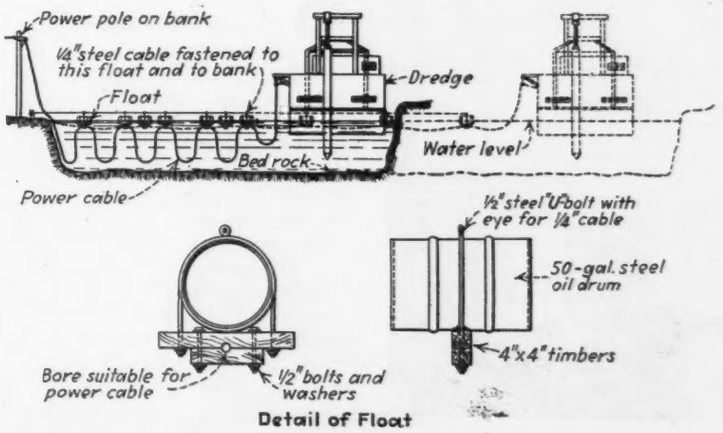
Novel Power-Cable Suspension

OF INTEREST to gold placer dredge operators in general, writes C. H. Thurman, superintendent, Gold Hill Dredging Company, Folsom, Calif., will be the simple scheme developed recently by Lon Monroe, chief electrician, for carrying the power cable in large dredge ponds.

At Loomis, Calif., where the company operates a 9-cu.-ft. dredge, it was necessary to levee the channel to be dredged, and as a consequence the adjacent land was submerged under several feet of water. The artificial lake thus created was quite deep and full of tree stumps—obstacles that made the conventional method of suspending the power cable questionable. To facilitate moving the dredge from one cut to another and provide for safe operations, the power cable had to be flexible as to length and so suspended as to make entanglement on the lake floor impossible. The problem was solved by suspending it from floats spaced at intervals as shown in the sketch. The floats are made from welded-up 50-gal. steel grease barrels, to which wooden clamps are secured by large "U"-bolts made of ½-in. round steel bar. The clamps are of 4x4-in. timber. Each "U"-bolt has an eye through which is passed the ¼-in. steel cable leading from the anchorage on the bank to the float nearest the dredge. By placing the floats at proper intervals, adjustment of the power cable is automatic, when the boat is moved from one cut to the next.



SUSPENSION of the power cable between the dredge it serves and the edge of the pond in cases where the cable is likely to be caught and tangled by stumps on the bottom of the pond is effected in the manner shown here in sketch and photograph, which involves the use of floats as illustrated. The dredge seen in the photograph is that of the Gold Hill Dredging Company, near Folsom, Calif.

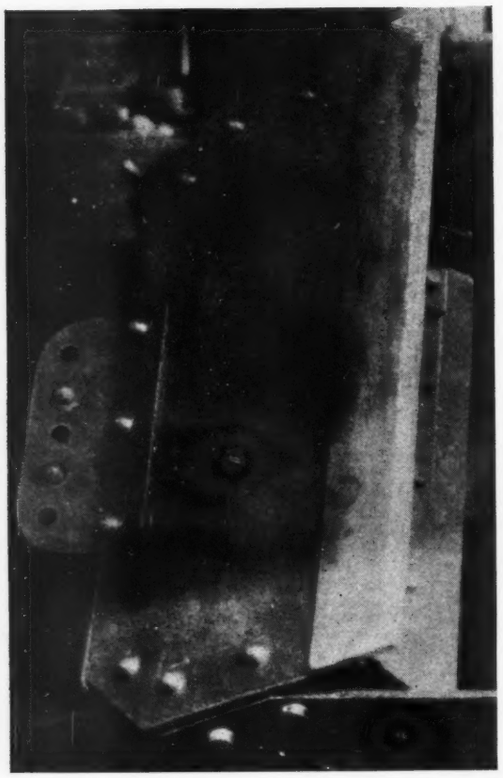


Detail of Float

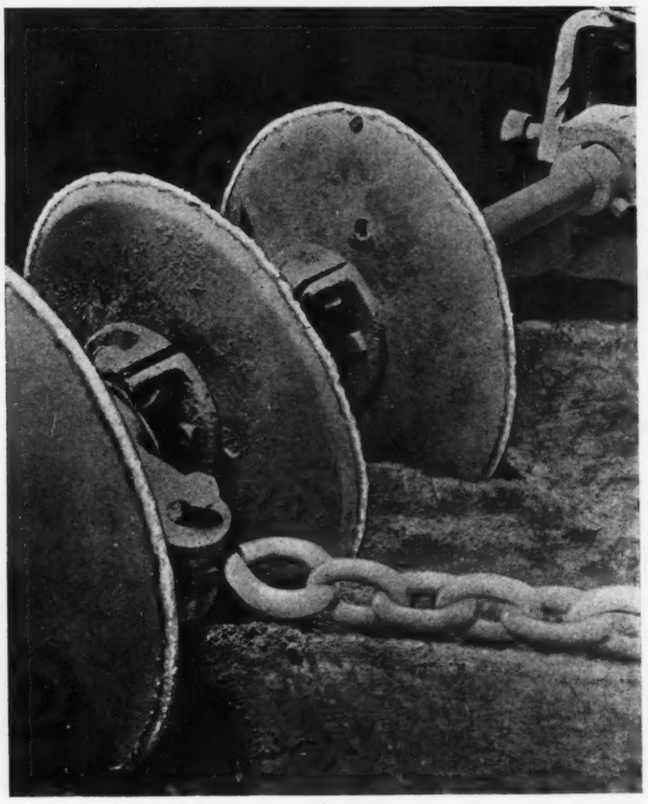
Hard-Facing

More Serviceable Than Ever

This welding process adds to life of wearing parts



THIS SCRAPER BLADE has been hard-faced and now lasts three or four times longer than before hard-facing was applied



RABBLE DISKS such as these ordinarily wear down from 18 in. in diameter to 11 in. in six months. In a similar length of time, hard-faced disks have shown comparatively little wear

STRIPPING KNIVES of cobalt-chromium-tungsten alloy last indefinitely in the work of removing cathode starting sheets in electrolytic copper refineries

WEAR-RESISTANT metals applied by the welding process, known as hard-facing, are being widely used to protect the wearing parts of machinery and equipment such as is used in the production of copper and other metals. From the mining of copper ore, through all subsequent handling operations and smelting, as well as in electrolytic refining, hard-facing continues to find new applications. The following examples supplement others already published in *E.&M.J.*, Sept., 1934.

Blades of dragline scrapers and of scrapers used underground are often coated with a ¾-in. wide layer of non-ferrous alloy. Protected in this way, they last from three to four times longer. Ore-car coupler knuckles have also been hard-faced successfully. About 100 couplers can be protected with 1 lb. of non-ferrous alloy, and instead of lasting only two months, as they did before the introduction of hard-facing, they should now last for over a year of steady use before refacing is necessary. Hard-faced shovels, too, are used successfully in loose earth.

Skip guides are economically hard-faced with a wear-resistant alloy. In one Utah plant, ordinary skip guides lasted but ten days; 2½ lb. of stellite (cobalt-chromium-tungsten hard-facing alloy) applied to each of the four guides on each skip prolonged the guide life to three months. Hard-facing the horns on the skip dumps is also standard practice at some mines.

In roasting, rabble disks are economically hard-faced. A Nevada superintendent has had good results from hard-facing these parts. In six months, ordinary disks wore down from 18 in. in diameter to 11 in. For a similar period, however, disks protected by hard-facing alloy applied $\frac{1}{8}$ in. thick and 1 in. wide around the outer edge have shown very little wear. About 1 lb. of hard-facing material is required to cover each disk.

Matte ladles are subjected to considerable wear and corrosion from contact with hot material. For some time, welding was used to repair the damage in a Southwestern plant, but the results were not as successful as desired, because the metal deposited in the fracture was eaten away by the matte. In burned spots, the patches were literally torn out after the ladles had been put back into service. Patching these ladles with a chromium-manganese-iron hard-facing material has made a success of this operation. Patches and cracks so built up wear longer than the original material of the ladle.

Hard-facing alloys are also useful for handling chemicals. Pumps for circulating sulphuric acid solutions last many times longer when the inlet and outlet passages are covered with this material, for example Hastelloy. This application demonstrates the effectiveness of non-ferrous hard-facing alloys against both wear and chemical corrosion.

Knives made of castings from hard-facing alloys, for stripping deposited copper from the starting plates, have given exceptional service at a Montana copper refinery. However, ordinary steel knives may be hard-faced and give almost the same length of life. The experience of a Montana refinery is of interest. The first solid cast knife tried by this refinery was lost. Several months later in cleaning out one of the cells in the tank room, it was found in a tank and showed no effects of corrosion.

Ore-handling equipment is much more economical if the innumerable wearing surfaces are hard-faced. Fewer replacements and less expensive replacement expenditures result in better, more efficient production. Often, complicated pieces of apparatus of expensive design must be scrapped merely because the surface is worn to less than tolerance. When the worn surface of such a part is hard-faced, the reconditioning cost is lower than the cost of a new part, and the hard-faced part will usually last considerably longer and will render better service.

Many small, troublesome parts also require less attention when protected by this process. For instance, ore-belt clips, skip guide shoes, latch bars and keepers, conveyor sprockets and flights, parts of rock drills such as slides, frames, water feeders, and air swivels can be made to last longer and give more continuous service.

Measuring Distance Between Lines of Sight of the Main And Auxiliary Telescopes

TO CORRECT ANGLES taken with an auxiliary telescope it is necessary to know the center-to-center distance from the main to the auxiliary telescope. Though this information is generally given on a card inside the instrument case, sometimes it becomes necessary to check it. Recently, it was necessary for us to measure this distance accurately for one of our mine transits. Direct measurement is inaccurate and difficult. The following outlines the indirect method which we employed, and it proved to be satisfactory. A steel tape is all the equipment required, and the measurement may be carried in any degree of accuracy desired.

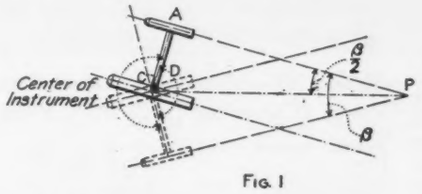


Fig. 1

Set up the instrument in a convenient outdoor location; attach the auxiliary telescope and adjust its line of sight to parallel that of the main telescope. This may be done by sighting the main telescope on some well-defined object, say the top of a triangulation station a mile or two distant, and adjusting the line of sight of the auxiliary telescope to the same point. Now establish some small, well-defined point such as a pin 30 to 50 ft. from the instrument. First, we shall consider a determination when the auxiliary telescope is on the side.

With the auxiliary telescope on the right side and with the vernier reading zero, sight the established point with the instrument. Loosen the top motion and invert or transit the instrument. This will place the auxiliary telescope on the left of the main telescope. Again sight the point and record the vernier reading. This reading, minus 180 deg., is the angle from the point P to the two respective center locations of the auxiliary telescope; or, referring to the accompanying sketch, is angle β in Fig. 1. Now, if the measurement AP is taken and multiplied by the tangent of $\frac{\beta}{2}$ the result will be the distance AC, which is the required distance. A greater degree of accuracy may be obtained by doubling or repeating the angles.

A similar determination was made with the telescope in the top position. The line of sight is made parallel as described previously, but since it is impossible to transit with the telescope in this position, the procedure is changed. The initial sight is taken with the main telescope. Then the vertical limb is read and recorded. The point is now sighted with the auxiliary telescope and the vertical limb again read. The difference between the two readings will be the angle Δ in Fig. 2. In this case it is usually more convenient to measure the distance CP, in which circumstance the sine of Δ will be used. Also, since no reversal is possible, the angle measured is used as read and not divided by two, as in the first instance. In the second instance, it is impossible to double the angle.

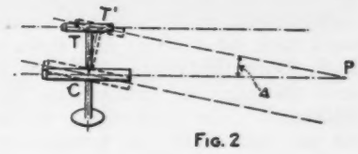


Fig. 2

Following are two typical calculations with the telescope in the two positions.

Auxiliary Telescope on Right Side

Single Angle = β = 0°34′
Double Angle = 2β = 1°08′
$\frac{\beta}{2}$ = 0°17′

Measured distance = AP = 52.70 ft.
Log AP = log 52.70 = 1.72181
Log tan $\frac{\beta}{2}$ = log tan 0°17′ = 7.69418
Log distance AC = 9.41599
AC = 0.26062 ft.

Auxiliary Telescope on Top

Angle Δ (read three times) = 0°16′
Measured distance = CP = 56.01′
Log CP = log 56.01 = 1.74827
Log sin Δ = log sin 0°16′ = 7.66784
Log distance TC = 9.41611
TC = 0.26068 ft.

For the average instrument a distance of 50 ft. will give a working angle of about fifteen minutes; a distance of 25 ft. an angle of about thirty minutes. The taping error for 50 ft. should not exceed 0.01 ft. and the angular error, with an instrument which reads direct to one minute, should not be more than 30 in. This would mean that the distance sought should be accurate within the required limits of accuracy for any mine survey work usually encountered.

New Mill At Cripple Creek

(*Continued from page 551*)

The classifier overflow is pumped to a 35-ft. Dorr thickener. The overflow of this thickener, being the pregnant solution, goes to the clarifier tank. Thickener underflow, at 60 per cent solids, is run to an 18x18-ft. Denver Superagitator, where enough mill solution is added to give about 34 per cent solids. The pulp overflowing this agitator passes in turn to two similar machines in series. From the third agitator the pulp enters another 35-ft. Dorr thickener. The overflow of the latter goes to the mill solution stock tanks, where it is fed through a steady-head tank to one of three weirs distributing solution to the grinding circuit, Esperanza classifier, and the No. 1 agitator.

The No. 2 thickener underflow at 60 per cent solids is diluted with barren solution (which is measured from the stock tank by a weir) and flows to a 50-ft. Dorr thickener. Overflow from this thickener is pumped to No. 2 thickener. The underflow, at about 60 per cent solids, is pumped to an 8-ft. six-disk American filter. Here it is first washed with barren solution and then water, leaving the filter at about 20 per cent moisture. From this filter the cake discharges into an 18-in. inclined-belt conveyor running at 20-deg. inclination and is stacked on the hillside behind the mill. The filtrate is sent back to No. 3 thickener. The only water added to the circuit other than on the filter is an occasional small quantity from cleaning floors.

Pregnant solution is clarified by passing it through canvas leaves 6x8 ft. in area hung in a porous-bottom tank. Solution is also filtered through the sand bed in the bottom of the tank. The clarified solution is passed through a vacuum tank 6 ft. in diameter by 12 ft. high and is then pumped (by a 3-in. centrifugal pump) into the precipitation press, zinc dust having been added through a cone to the pump intake. This press is opened and cleaned three times a month.

The precipitate is roasted with niter in a roasting furnace and is then fluxed and melted in a tilting crucible furnace fired by fuel oil. The furnace is charged continually and, occasionally, slag is drawn off until all the precipitate has been added. This slag is finally poured into a pot and the bullion left in the crucible. Niter is then added and the bullion refined by stirring. After the bullion has been thus treated, the retort metal from the amalgamation of the table concentrates and all the refined bullion from resmelting of slag are added and the whole is poured into an iron mold. The bar is then cleaned, drilled, and weighed. All bullion is shipped to the Denver Mint.

After the melt is completed, all the slag is charged back to the furnace. Fluxes and litharge are added and a base bullion is formed. This is cast into small ingots and these are cupelled for the contained gold and silver bullion. The finished slag is leached to remove the soluble sulphates and salts and is then fed to the ball-mill circuit.

The fluxes used, and their quantity, depend largely on the analysis of the precipitate. In general the following chemicals and quantities are used:

Niter (10 per cent by wet weight of the precipitate) is thoroughly mixed with the precipitate before roasting. To this mixture, after a long roast, is added 13.6 lb. manganese dioxide, 12.7 lb. ferric oxide, 23.0 lb. lime, 78.0 lb. borax (granulated), and 44.0 lb. silica. In resmelting the slag 3 lb. of litharge is added to the charge. The bullion produced averages 765½ fine gold and 092½ fine silver.

Consumption of materials in the cyanide plant is given in Table VI.

Table VI—Materials, Labor, and Power (Consumed in Cyanide Plant)

Sodium cyanide	1.38 lb. per ton
Lime	18.70 lb. per ton
Zinc dust	0.24 lb. per ton
Lead nitrate	0.02 lb. per ton
Forged-steel balls	1.22 lb. per ton
Labor	0.48 man-hr. per ton
Power	44.8 kw. per ton

Average cost per ton treated for July was $1.56.

Recoveries at present are around 95 per cent, but improvements being made in plant arrangement and practice indicate better recoveries in the near future.

The Assay Office—The plant is equipped with a thoroughly up-to-date assay office. Assay furnaces are coal-fired and are built in two sections, each having two muffles. It is arranged so that two men may work entirely independently of each other. One assayer handles all the control work while the other takes care of the mill assaying.

Mill Control—Control of the mill operation is secured by careful sampling of all products and pulps and solutions in circuit. One man is kept busy at the work of preparing these samples, most of which are taken automatically over the 24-hour period but divided according to the three eight-hour shifts.

The plant has a rather complete ore-testing laboratory, where all new ores are tested for metallurgical classification and where plant problems are worked out.

Numbered among the plant personnel are L. S. Harner, plant manager; J. R. Fyfe, general superintendent; C. E. Tonry, mill superintendent; Isak Partanan, metallurgist; C. N. Keown, foreman of roasting and cyanide departments; James Hanvey, mill control; A. B. Miller, crushing and sampling works foreman; F. H. Whitman, chief assayer; and J. L. Henshall, chief clerk.

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Bevel Gears Machined in a Planer

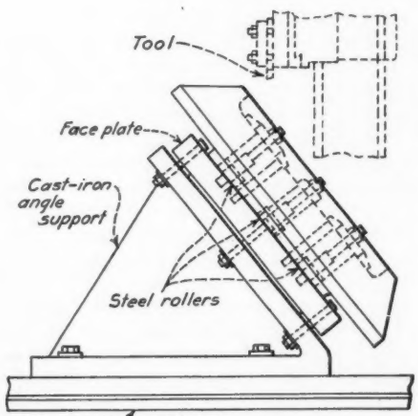


FIG. 1

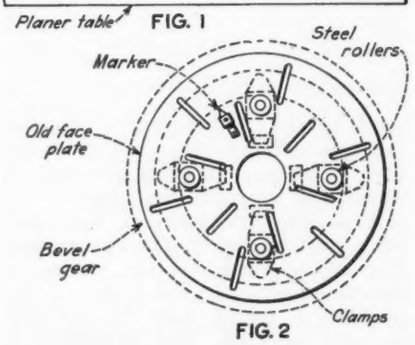
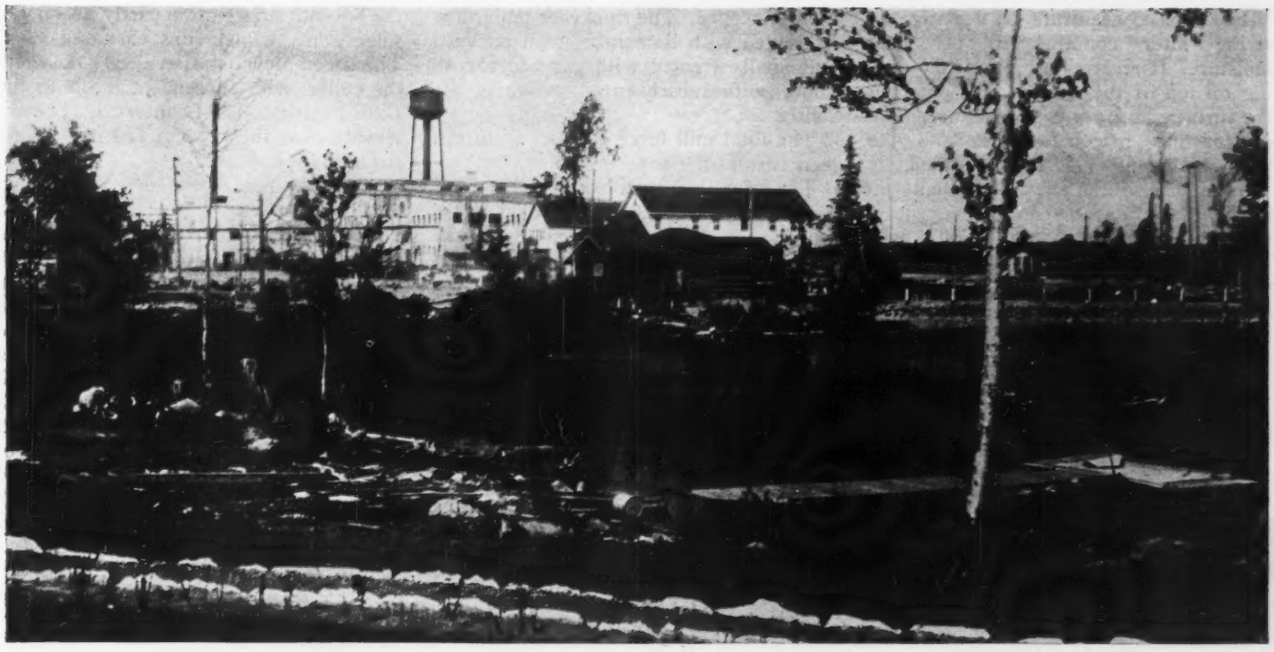


FIG. 2

CUTTING LARGE bevel gears often presents a difficult problem in shops where suitable equipment for such work is lacking. Gears on crushers, tanks, and roasters in particular are subject to rapid wear and must be changed frequently. Usually, worn teeth are built up by acetylene or electric welding and then ground to size by hand or machined in homemade jigs attached to the shaper.

J. A. McHugh, shop foreman at Magma Copper Company, Superior, Ariz., confronted recently with the task of reconditioning several large gyratory crusher gears, solved the problem successfully in the manner explained in the accompanying sketch. Here the work is done in the large planer available at the shop and the set-up consists of an old face plate fitted with four tempered-steel rollers and a marker, and a cast-iron angle support bolted onto the table of the planer. The gear proper is secured to the face plate held to the angle support by four bolts by clamps locked by nuts on the threaded ends of the roller shafts. The four rollers operating in the bore of the gear permit easy turning and quick adjustment of the gear after a tooth has been completed.



A PICTURESQUE SETTING enhances the view of the Little Long Lac Gold Mines camp, when seen from the proper angle. Situated on the edge of the lake from which the district takes its name, the camp would be suggestive of a summer resort to many visitors. This photo and the accompanying night scene were taken by Mrs. Abbott Renick, wife of the mill superintendent.

Little Long Lac Gold Area

Scene of Promising Activity

Recent finds, following the initial strike of 1932, strengthen the position of this northwestern Ontario district as a producer

A. H. Hubbell
Associate Editor

FOUR YEARS AGO, when good values in gold were discovered on what is now the property of the Little Long Lac Gold Mines, Ltd., about 20 miles west and south of the Longlac station of the Canadian National Railways, in the Thunder Bay district of northwestern Ontario, prospectors flocked into the region, which enjoyed the limelight for a time. Development of the Little Long Lac mine was pursued and work done on adjacent properties. With the advance in the price of gold in 1933, a new stimulus was given to operations. As a result of this and the development work it had been doing in the meantime, the Little Long Lac company was able to start a cyanide-amalgamation plant in the latter part of December, 1934. This has been running continuously ever since. Last summer flotation equipment was added to treat the tailings, and still more recently an Edwards roaster to roast the flotation concentrate, which is then cyanided separately from the original feed. Thus the flowsheet of the plant, which is shown on page 572, presents an interesting combination of cyanidation, amalgamation, and flotation, together with the use of blankets and roasting.

Treating 7,500 tons monthly, a tonnage which is not yet up to capacity, with an over-all recovery of 95 per cent, the mill recovers 70 per cent of the original mill heads by the use of corduroy blankets. Cyanidation of the blanket tailings adds 15 per cent, with the cyanide residues passing to flotation.

The roasting plant handles monthly 120 tons of concentrates which assay 4 oz. of gold, 23 to 24 per cent sulphur, 12 to 14 per cent arsenic, 25 per cent iron, and 8 per cent insoluble. The calcine contains ½ to 1 per cent of sulphur, 0.7 per cent arsenic, and 6 to 6½ oz. of gold. It contributes 10 per cent of the original mill values. The following data will supplement the facts given in the flowsheet.

Grinding is done in water with an average alkalinity of 0.40 lb. CaO. The combined product from the primary classifier overflow and the tube-mill discharge passes to seven corduroy blanket tables having a total effective area of 189 sq.ft. and sloping 1½ in. to the foot. Blankets are washed at 1¼-hour intervals. In the amalgamation section the blanket concentrates are ground for 16 hours beginning at 4 p.m. daily. Ninety pounds of mercury is added at 8 a.m. the following day and left in the barrel for 1 hour and 10 min. while grinding continues, after which the daily clean-up is begun. Average loss of mercury is 20 lb. per month.

In cyanidation, the strength of solution is approximately 1 lb. per ton, with a protective alkalinity of 0.30 lb. CaO per ton. The pulp is agitated 35 hours at 1 to 1 dilution. Screen analysis of the residues shows 13.3 per cent plus 200 mesh and 86.7 per cent minus 200 mesh.

The tailings from cyanidation, after being conditioned, pass to flotation containing 35 per cent solids and averaging 9.7 pH. Consumption of reagent is as follows: Copper sulphate, 0.55 lb.; soda ash, 1.50 lb.; pine oil, 0.04 lb.; and xanthate mixture, 0.08 lb. The mixture consists of potassium ethyl and amyl xanthate.

Flotation concentrate on leaving the string filter contains 10 per cent moisture. It receives a preliminary drying on top of the roaster flue, entering the furnace at 5 per cent moisture. The roaster has fifteen spindles and the total effective area is approximately 350 sq.ft., providing roasting capacity up to 8 tons per day of concentrate which screens 98 per cent minus 200 mesh. The furnace is oil-fired, with a temperature around 400 deg. C. on the feed end and 600 deg. C. around the eighth rabble. Rabbles 1 to 10 inclusive have a speed of 2 r.p.m. and the last five rabbles, 4 r.p.m.

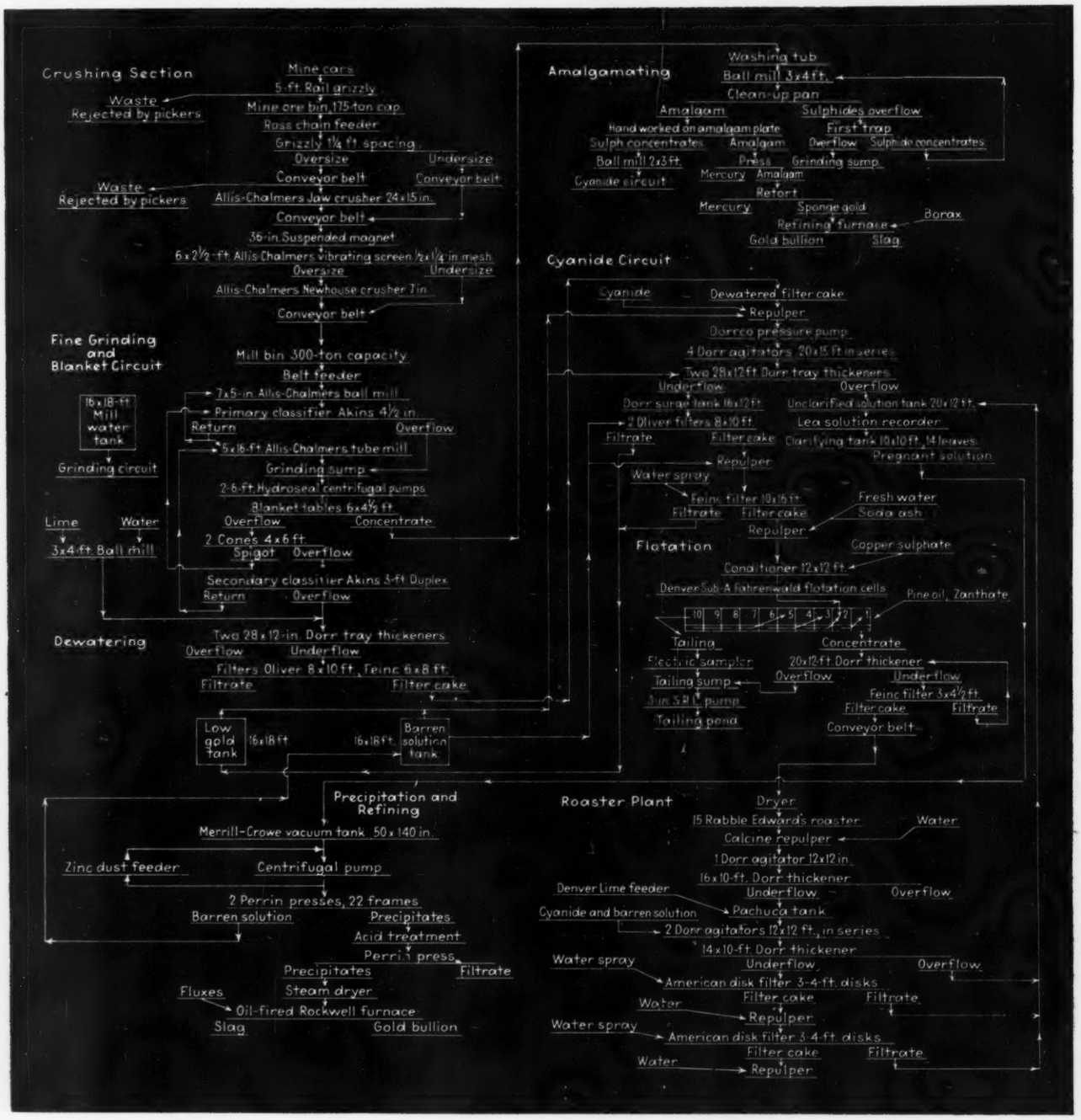
Calcine from the roaster is pumped to No. 1 agitator for water-washing and then thickened. The thickener underflow is treated with lime in a small pachuca and finally treated with cyanide for 48 hours, with subsequent filtration of the solids.

The total mill force consists of fifteen men besides the superintendent.

The mine is opened by one three-compartment shaft, 1,040 ft. deep, from which five levels, the second to the sixth inclusive, have been opened and fully developed on the main ore zone, and the seventh and eighth partly so on the same zone, which runs east and west. The second-level station is 204 ft. below the collar, with subsequent levels to the sixth having a 125-ft. interval. The interval below the sixth is 150 ft.

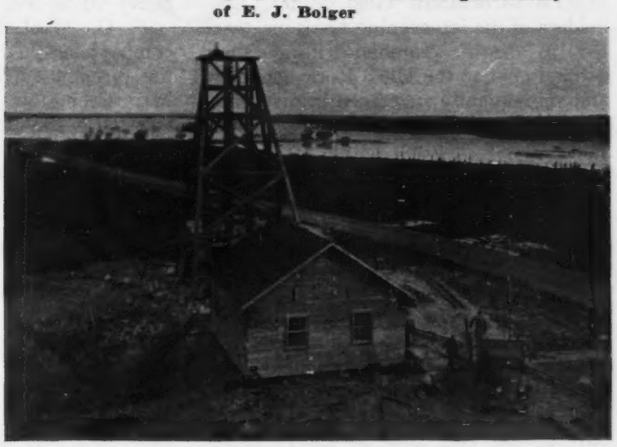
Development work totals 10,700 ft. Stoping, at first done by shrinkage, is gradually being changed over to the horizontal and rill cut-and-fill methods. Stope length is 125 ft., with a timbered manway between adjacent stopes. Average stoping width is 8 ft. outside of a wider section which occurs east of, and close to, the shaft on the second level and extends almost to the third level. This widening is caused by a local folding condition and makes ore for a width

MILL FLOWSHEET of Little Long Lac Gold Mines. Few plants can show more varied practice. Much of the gold is recovered on blankets. Equipment is also available for treatment of the ore by amalgamation, flotation, and cyanidation, with roasting preliminary to the last, if necessary



MacLEOD-COCKSHUTT'S CAMP at left. The tract of ground on which core drilling has disclosed the ore reserves now credited to the company is a ten or fifteen minutes' walk from here

HARD ROCK Shaft No. 2 on "Porphyry Hill" with Shaft No. 1 in the distance out in the lake. This and the accompanying view of the Hard Rock property are shown through courtesy of E. J. Bolger

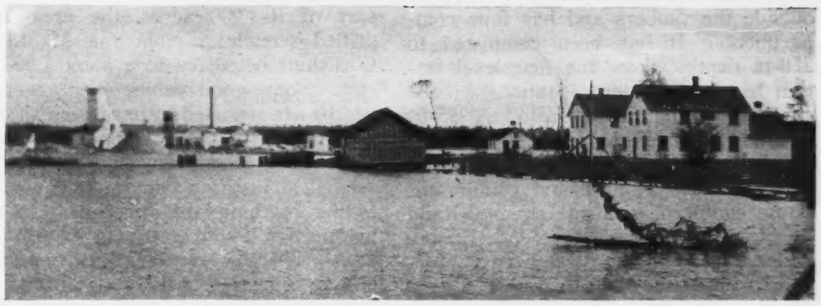


of 48 ft. (between walls) over a length of 60 ft. on the second level, where it has been completely slashed out drift height (7 ft.). Where it starts above the third level the stope is being back-filled and the manway square-setted in preparation for continuation as a cut-and-fill stope.

The ore occurs as free gold and also associated with pyrite and arsenopyrite in a series of parallel east-and-west quartz stringers forming a definite mineralized zone, in a formation that has been called arkosic graywacke. This formation, as determined by drilling and underground development, is folded so that on a surface map of the area it appears to lie in a 700-ft. wide band sweeping from southeast to northwest and then around to the northwest, dipping steeply to the outside of the curve. The Little Long Lac east-west vein system lies along the axis of the fold, where the arkose attains a total width (length along the axis) of 1,050 ft. Both over and under this arkosic graywacke formation as it dips downward occurs a banded graywacke which seems to form quite definitely the limit of the Little Long Lac ore on the west, the workings having already reached it on three levels. To the east only one level has as yet gone far enough to cut the banded graywacke.

On the second level extending east of the folding in the main ore zone, and about 30 ft. north of and paralleling the eastern continuation of the main zone, a further ore zone has been followed 230 ft. Drifting indicates a grade of 0.30 oz. over drift width. This ore has not been delimited to the east.

SHAFT NO. 1 and camp buildings (below) of Hard Rock Gold Mines, Inc. This shaft opens the older part of the company's property



On the fourth level, two parallel ore zones, 30 ft. and 60 ft. respectively north of the main zone, have been opened for over a hundred feet in length each. Both zones grade slightly under half an ounce over drift width. These two zones may have some connection with that on the second level and with the folding condition encountered there.

On the fourth level a crosscut started 300 ft. east of the shaft and driven south about 450 ft. has intersected a mineralized zone, parallel with the main zone, which has been followed eastward for 400 ft. This vein appears to be dipping northward toward the main vein at this level, suggesting the possibility of its joining the main vein at depth. So far as the geology has been determined, the economic mineralization appears to be confined to the arkosic graywacke and at those points where some movement has taken place. Ore reserves as shown in the last annual report are 320,755 tons averaging 0.515 oz.

Hoisting is done with a Canadian Ingersoll-Rand double-drum hoist having a capacity of 1,300 ft. of $\frac{7}{8}$-in. rope and driven by a 150-hp., 2,200-volt induction motor. Air is supplied by a 2,000-cu.ft. Belliss & Morcom compressor and a Canadian Ingersoll-Rand PRE-2 1,200-cu.ft. machine. A 360-hp. diesel-driven generator has also been installed.

Joseph Errington is president of the Little Long Lac company and Alan A. Barton general manager. Under Mr. Barton are Abbott Renick, mill superintendent, and George A. Grant, office manager. J. Kilpatrick is mine superintendent.

LITTLE LONG LAC GOLD MINES CAMP at night. Thanks to the reflection in the water, the view is almost as good inverted as it is here. At the right are the mill and general office. The two large buildings at the left are boarding houses for the men

MacLeod-Cockshutt

Gold mining in the Little Long Lac area received another stimulus when in the latter part of February of this year, thanks to the previous discovery of

high-grade gold ore on the western edge of the ground of the Hard Rock Gold Mines which lies about 3 miles southeast of the Little Long Lac property, the MacLeod-Cockshutt Gold Mines, Ltd., holders of the intervening territory, were led to begin diamond-drilling their ground next to the Hard Rock boundary and subsequently succeeded in disclosing the existence of a gold-bearing zone that runs continuously from the boundary westward, the distance covered up to the time of writing being some 1,400 ft., with about a mile to go before the western boundary of the area was reached.

Assays and widths, which have been variable, indicate the presence of an important tonnage of good-grade ore. Shaft-sinking in the footwall to the 500-ft. level was started on May 27, with the expectation of cutting the northern part of the vein zone at 150-ft. depth. This shaft is 22 ft. 10 in. by 6 ft. 10 in. outside the timbers and has four compartments. It has been completed to 210-ft. depth, where the first level station has been cut out. Stations will be cut at 350 and 500 ft. also. A 55-ft. wood headframe has been built and a 500-ft. trestle for dumping ore. The plant includes a hoist and compressor house equipped with an Ingersoll-Rand double-drum steam hoist, a 125-hp. boiler, and a 750-cu.ft. Belliss & Morcom compressor driven by a 180-ft. diesel engine.

Most of the time two drills have been at work and recently a third was added. The Sudbury Diamond Drilling Company is doing the work. Up to the time of my visit, in June, fifteen holes had been put down, making a total footage of about 6,400 ft., the longest hole being 846 ft. These have all been drilled north at right angles to the strike and have been started at an angle of 45 to 65 deg. to the horizontal, all of them flattening subsequently. The results indicate a dip of approximately 75 deg. south for the east-west vein and the inclosing formations.

As shown by the drilling, according to W. Samuel, geologist for the company, the upper parts of the holes are in massive graywacke. They then enter a banded zone of iron formation (thin, banded graywacke with bands of magnetite and hematite) and sericite schist, which may be arkose or porphyrite. In this banded formation the ore occurs in heavy mineralization on the contacts between the sericite schist and graywacke or iron formation. Where the sericite schist is a wide zone, ore occurs on two contacts. Where there are a number of bands of sericite schist, the occurrence of ore on numerous contacts gives a wide zone. The lower parts of the holes appear to be in fragmental arkosic rocks approaching sericite schists. In the sericite schists various quartz stringers occur which occasionally carry a little gold.

The mineralized formation carries a varying percentage of iron sulphides, chiefly pyrite with some arsenopyrite. The gold appears to be quite fine—some of it free. At times it is associated with heavy sulphides, but not necessarily so.

F. G. MacLeod is president of the company and Arthur Cockshutt one of the directors. The board also includes Mr. Errington, who is likewise interested in the Little Long Lac company, as already mentioned, and in the neighboring Hard Rock and Bankfield companies.

Hard Rock

THE DRILLING on the Hard Rock property to the east of the MacLeod-Cockshutt holdings which led to the present notable developments on the latter was done by the Hard Rock Gold Mines, Ltd., last fall. In all, the company now has approximately 20,000 ft. of drilling, most of it in the northwest part of its 900 acres, the area here drilled stretching from the MacLeod-Cockshutt boundary to a point 1,000 ft. east. Some good values over generous widths are reported to have been shown. The results of the various holes, however, have not been sufficiently correlated to justify a definite statement as to the continuity of mineralization and prospective tonnage of ore within the area. There is every reason, nevertheless, to suppose that the mineralized area continues well across the boundary. The drilling done has disclosed four oreshoots. A shaft is now being sunk 1,000 ft. east of the west boundary, and at the time of writing was 60 ft. deep and in ore all the way. Incidentally, this section is part of the Porphyry Hill area on which, to the south and east, the Homestake Mining Company put down a few holes in 1932. On this latter part of the ground, also, the Hard Rock has now begun to drill.

About a quarter mile southeast of the Porphyry Hill section is the area on which the Hard Rock company, after drilling in 1933 and '34, started a shaft in the latter part of 1934. This shaft is now 450 ft. deep and drifts have been run east and west on the 200, 325, and 450-ft. levels. The vein has been developed on all three, in widths ranging from 1 to 20 ft. It is in general strongly defined—perhaps more so than in the Little Long Lac—and consists of quartz stringers in arkosic graywacke, these now forming a single vein, now splitting up into a series of stringers. It is fairly steep in the west end. The gold occurs in quartz; sometimes free, sometimes associated with sulphides. The work is entirely of a prospecting nature at present and no attempt has been made to block out tonnage. In fact, little work has been done between levels, such as would be necessary before hazarding any estimate. Values are marginal on the first level, but then improve on the levels below.

From the bottom level, in a crosscut driven 380 ft. south of the shaft, a 125-ft. winze is being sunk in an effort to get more information. Development of 575-ft. level is now under way. A force of 56 men, not including the diamond-drill crews, is employed. J. C. Dumbrille is general manager and E. J. Bolger mine engineer.

Bankfield

JUST as the MacLeod-Cockshutt holdings adjoin the Little Long Lac ground on the east, the property of Bankfield Gold Mines lies next to it on the west, situated on Magnet Lake approximately 6 miles from the Little Long Lac mine and 3 miles south of Bankfield station on the railroad. The holdings comprise sixteen claims covering 728 acres.

According to W. H. Woods, consulting engineer for the company, who supplied the following data, the ore here occurs as lenticular bodies in highly altered and silicified sediments and porphyry, adjacent to the north contact of a large mass of quartz porphyry. It is of two types: high-grade ore, carrying considerable native gold together with the ordinary sulphides; and low to medium grade, consisting of massive and disseminated sulphides, generally running from 4 to 10 dwt. in gold. The sulphides in the latter case are pyrite, arsenopyrite, and traces of pyrrhotite.

Since the ground was acquired in May, 1934, at which time diamond drilling was begun to explore two mineralized zones on which interesting gold values had previously been found, over 17,600 ft. of hole have been drilled. The absence of outcrops along the greater part of the two zones has made the exploratory work difficult and slow.

The property has been developed by a 4½x5 ft. (inside dimensions) vertical, three-compartment shaft to a depth of 525 ft., with levels established at 150, 275, and 525 ft. These have been connected by raises in the ore zone. Up to the end of August, 7,200 ft. of drifts and crosscuts had been driven, with 780 ft. of raises.

Bankfield's reserves are estimated at 65,144 tons of ore averaging 16 dwt. in gold, or 12.2 dwt. after cutting the high assays, these figures being based on drift widths. The tonnage that will be mined, however, is expected to prove greater than this, according to Mr. Woods, for the reason that test holes drilled in the drift walls at 5-ft. intervals have shown 5 ft. additional width of ore. The increase in tonnage will probably be accompanied by a slight drop in grade.

A transmission line is being run to the property and the present steam plant is being changed over to electric power. The hoist will be a 42x30 PE-1 Ingersoll-Rand machine of 1,500-cu.ft. capacity.

Designs are now being drawn up for a 100-ton mill, using straight cyanidation. Work on the foundation is now under way.

NEWS
OF THE INDUSTRY

Mining Congress Discusses Economic and Legislative Matters at Denver

PROGRAM FEATURES TALKS by Hoover, Landis, and Finch on Taxation, Mine Promotion, Power, and Other Topics at Well-attended Convention

ATTRACTED by an unusual array of headliners and a program of vital importance to the metal-mining industry, Western mining men gathered in large numbers for the annual meeting of the Western Division of the American Mining Congress at Denver, Colo., on Sept. 28. Primary interest centered in matters of public policy growing out of New Deal legislation and directly affecting the future welfare of the metal-mining industry. At the close of the meeting "A Declaration of Policy" was unanimously adopted, expressing the attitude of the Western Division on taxation, finance, tariffs, Government in business, labor, relief, and other similar matters of public concern.

The board of governors of the Western Division selected Salt Lake City, Utah, as the meeting place for the fall of 1937, and elected Oscar N. Friendly chairman. Mr. Friendly is vice-president and general manager of Park Utah Consolidated Mines Company.

Taxation received the major attention of the Congress. It was the theme of three speakers—H. B. Fernald, chairman, Executive Tax Committee, American Mining Congress; E. C. Alvord, tax attorney, Washington, D. C.; and Herbert Hoover. Each approached the subject from a different viewpoint. Mr Fernald made a technical analysis of the 1936 Revenue Act as it affects mining companies. Regardless of the wisdom of the Act, he urged mining companies to take it seriously and study it intently. No abstract can do justice to Mr. Fernald's address. It will have to be read in whole if its excellent advice and counsel are to be usefully applied. The intricacies and complexities of the Act are such that "the courts will probably be wrestling with them for long years after the present law has been superseded by another."

Mr. Alvord looked at taxation in its relation to Government spending and the budget. Characterizing the latter as "an IF budget," he cited ten "ifs" surrounding the Government's fiscal plans and policies. He recommended that the Administration determine the maximum revenue that can be raised by intelligent taxation, and cut expenditures to bring them within this amount.

Hoover Condemns Profits Tax

MR. HOOVER, speaking at the banquet, was in rare form. Relaxed, at ease and in a friendly atmosphere, he paid his respects to the methods of taxation, rather than to burden of taxes. "Having teeth pulled is necessary, but the technique of the dentist may add grief to the *n*th degree and may injure the patient for a long time." Of the corporation tax on undistributed profits he said:

"Anyone familiar with the growth of the West knows the mining industry has created and expanded from plowing in its own profits. Nor can it be done any other way. But the new law steps in and says that if you use your profits to prove and build up this business you must pay the Government up to over 40 per cent on these profits. That is a tax of up to over 40 per cent upon improvements which give men jobs.

"Furthermore, metal mining in the early stages happens to be the most speculative of all business. On balance, more money goes into this stage of the industry than ever comes out.

"If the Government is going to take up to 40 per cent of the temporary profits from each ultimate failure, as well as the successes, the miner does not stand a dog's chance.

"Somewhat the same situation applies to large low-grade deposits. Many of them which have been made successful industries by plowing in the profits of the first unit would never have started had they tried to find all the capital at once.

"Here again this tax up to 40 per cent on profits becomes a tax on improvements that would give men jobs.

"This taxation favors the big mining corporations. These concerns already have capital reserves; they can secure capital on easy terms. They can take up a dozen prospects and write off the losses against profitable ones."

Financing the Mining Industry

JAMES M. LANDIS, chairman of the Securities and Exchange Commission, outlined the scope of the Securities Act of 1933, and the problems of the SEC in administering that Act with respect to the mining industry. Revealing a sympathetic understanding of the problems of the mining industry, and its importance in the national economy, Mr. Landis emphasized the speculative nature of the business:

"This very fact, unfortunately, has been seized upon by unscrupulous promoters who use it as a lever for the development of their schemes. The speculative nature of mining is used as a pretext and a justification by those who promote securities rather than mines and who are ever ready to promise a pot of gold at the end of every rainbow. I cannot emphasize this fact too much, for it is of vital concern to recognize that the very characteristics of this splendid industry are such as to make it possible for men with no conscience to bring discredit upon it."

The SEC has taken cognizance of the peculiar conditions surrounding the financing of mining ventures, particularly those in the promotional stage, and has proposed new regulations for public offerings of stock in amounts less than $100,000 (*E.&M.J.*, Aug. 1936, p. 427). After outlining the salient features of the plan, Mr. Landis said: "That some ironing out will have to take place is obvious. But I believe that you can count on us to show a non-technical, liberal temper in dealing with the problems which registration may raise. Our function is to be industrially minded. Indeed, my conception of our work is that of the conservation of our financial resources. Every dollar that

(*Continued on page 576*)

RETORTING QUICKSILVER ORE in San Luis Obispo County, Calif. The war in Spain has created uncertainty as to her ability to continue mercury production, and as the price approaches $90 per flask here, more cinnabar deposits are being prospected and exploited in this country. Italy, also a large producer, is, however, increasing her production.

California

New Mill for Cactus Queen Mine Near Mojave

HEADFRAME AND HOIST being installed—New steel dredge begins work at Callahan

✦ According to a dispatch from Los Angeles, Cactus Mines, Inc., is planning erection of a 100-ton milling plant at the Cactus Queen and Blue Eagle properties on Middle Buttes, near Mojave. Installation of a new headframe and hoisting equipment is nearing completion, and plans are maturing for sinking the 400-ft. shaft to greater depth. About 2,000 ft. of lateral work has been done on the Blue Eagle vein, and 80,000 tons of mill ore are said to have already been blocked out. Improved ventilation has been provided by a raise, extending from the 400-ft. level and connecting with the winze sunk from the Otto tunnel level, completed recently. Roy W. Moore, Los Angeles, is in charge of operations.

✦ Preparations are under way at the Murchie mine of Empire Star Mines Company, Ltd., George Kervin, manager, Nevada City, to sink the main shaft another 200 ft. to the 2,300-ft. level. At the neighboring Gold Tunnel and California properties purchased recently by the company, diamond drilling is in progress to determine the extent and values of known orebodies. The Murchie mill is treating about 300 tons of ore a day, and a total of 300 men are employed at the property.

✦ Dredging operations have been started at Callahan, Siskiyou County, by Yuba Consolidated Goldfields, and the new 9-cu.ft. all-steel dredge is reported to be working satisfactorily. F. C. Van Deinse, vice-president, is in charge of all company operations. A second dredge unit expected to be completed early in January, 1937, near Yreka, Siskiyou County, is that of the Yreka Gold Dredging Company, E. Walker, president.

Additional air compressors have been installed at the Stockton Hill mine of Lode Development Company, where a vigorous development program is carried out underground, with 30 men employed. Marshall D. Draper is manager.

●

Quicksilver Production Increasing in Texas

✦ Mercury production from two mines and furnaces operating in the Terlingua district, Texas, is averaging three hundred flasks of quicksilver per month, each containing about 76 lb. Two of the mines from which the cinnabar ore is now being mined are those of the Chisos Mining Company and the Rainbow Mining Company. Since the first of the year, 24 carloads of quicksilver have been shipped from Alpine and Marathon, the nearest railroad points, about 90 miles from the mines. Each carload contained approximately 300 flasks. The price paid for the metal at the mines is said to be above $80 per flask. Several promising outcrops of cinnabar ore have been found near Terlingua during the year, and it is expected that these deposits may be opened in the near future, following more extensive development of these prospects.

Mining Congress

(Continued from page 575)

we prevent from going into an illegitimate scheme is a dollar saved not only for the investor but for industry. Every illegitimate enterprise that we break up is one more blow to unfair competition, one more step in the reconstruction of the investors' confidence in business itself."

Federal Power and Mineral Industries

WHAT ECONOMIC USE can the mineral industries make of the large quantities of electric power that will be available on completion of the Government's projects in the Western States—Boulder, Bonneville, and Grand Coulee dams? Answering his own question, John Wellington Finch, director of the United States Bureau of Mines, listed the following investigations by the Bureau and by Washington State College as promising power-consuming industries: electrolytic manganese metal, chromium or ferrochromium, metallic magnesium, electric smelting of non-ferrous metals, electrolytic antimony. Hope of building up electrometallurgical industries in the vicinity of the power projects depends on the possibility of developing new products or making standard products from raw material not now used but existing within reasonable shipping distance of the sources of power. Investigation of electrolytic manganese by the Bureau has already been described in this journal (*E.&M.J.*, Oct. 1936, p. 510). Other investigations are in various stages of development.

Rock Dust and Miners' Health

TWO PAPERS were presented on the subject of silicosis and its prevention. Dr. A. J. Lanza reviewed briefly the nature of the problem. "The fundamental principles are the same everywhere: First, to prevent, as far as possible, dust from getting into the air in working places; second, when it is present in the air, to prevent its inhalation by the workmen in harmful quantities. The methods of applying these principles are not only difficult but they still leave much to be desired. Still we can point to some noteworthy achievements." Dr. Lanza pointed out the difficulties in administering compensation laws on silicosis, and emphasized the need of skilled technical knowledge in diagnosing the disease and determining disability, saying, further, in part:

"One of the most vexatious phases of the effort to prove compensation for silicosis lies in the fact that in many industries there already are a considerable number of silicotics, some partially disabled, others with no disability. What is to be done with them? Compensation is essentially a matter of in-

surance, and you cannot insure against what has already occurred. This situation is very acute and cannot be dealt with by ignoring it nor by the wholesale discharge of those affected. Each State and possibly the individual industry will have to meet this problem by some special agreement or legislative enactment. What is to be the attitude of the employer to those in his employ who have silicosis? Is it necessary either for the best interest of the individual or the employer to discharge him? The answer is No. It is to be presumed that the employer in the light of recent knowledge and information will endeavor to reduce the dust hazard and adequately protect those exposed. In the absence of disability, therefore, the silicotic might best remain at his occupation. Disability practically always means that a tuberculosis infection has been superimposed upon the already dust-damaged lungs. The workman with active tuberculosis should be removed from the industry both for his own sake and the protection of his fellow employees."

Carlton I. Brown, of the Bureau of Mines, described and discussed equipment and methods for determining composition, concentration, and particle-size distribution of dust in mine air. Information on these properties is needed to establish what dust conditions are safe and to determine the effectiveness of dust-control measures. Many reliable dust-sampling procedures are available.

Three Outstanding Speeches

IN ADDITION to the papers on special topics, three inspiring speeches on current matters of broad interest to the mining industry were made by Col. Willard Chevalier, vice-president, McGraw-Hill Publishing Company; Senator William H. King, of Utah; and D. A. Callahan, president, Callahan Zinc-Lead Company.

In his keynote speech on "Today's Problems," Colonel Chevalier referred briefly to internal problems peculiar to the mining industry—competition with metals, the need of research, and national mineral policy—but devoted most of his attention to broader current public policies. He decried the tendency to believe that mechanization of industry is responsible for unemployment.

"In the face of all our experience," he said, "there are those who still believe that the increasing application of power and the development of new machinery and technique are responsible for the periodic visitations of widespread unemployment and its related evils. To combat such fallacy is one of the outstanding problems of all productive industry. The fact is that during the 60 years from 1870 to 1930 we had in this country the greatest development of new machinery and the most efficient industrial technique in all history, coupled with expanding employment and a miraculous rise in the general standard of living."

On the place of Government in an economic society he laid down the principle that "the participation of the Government should be confined scrupulously to that of regulation and supervision, with, in certain cases, some measure of coordination. Certainly it appears to be evident that only in rare cases and under great stress of public need should Government undertake the actual operation of productive enterprise."

Senator King addressed himself to the spending and taxing policies of the Administration, deploring both and urging a return to that "fine individualism" that has always characterized the American people. Of the capital-stock tax he said: "In a hazardous business such as mining it is unfair to require a company to stand on the value declared in previous years," and he urged the adoption of an amendment that would permit corporations to make a new declaration of capital stock value every two years.

Calling for "united action," Mr. Callahan made a stirring address in defence of business and industry. He urged a united front for the mining industry, not to obtain special favors at the hands of the Government but merely to secure fair and intelligent treatment at the hands of Federal and State legislators. To this end he suggested that State associations of mineral producers be organized to deal with local mining problems and to cooperate with the American Mining Congress in national matters.

Declaration of Policy

AT THE CONCLUSION of the meeting, the Western Division declared its collective views on taxation, cost of Government, extension of Federal supervision over business, competition of Government with private enterprise, equal responsibility of employers and employees for their acts, direct relief, open tariff agreements, and a metallic base for currency consisting of both gold and silver.

Luncheon for Callbreath

AN INCIDENT of major interest was the honorary luncheon to Secretary Emeritus James F. Callbreath. Well-deserved tribute was paid to his long years of service to the mining industry and to his untiring devotion to the work of the American Mining Congress. Mr. Callbreath organized the Congress in 1901 and served as secretary for 33 years.

In addition to many entertainment features throughout the week, trips to points of mining interest were arranged at the close of the sessions. One trainload of members went to the steel works at Pueblo as guests of the Colorado Fuel & Iron Company. Other parties visited Climax and Cripple Creek through the courtesy of Climax Molybdenum Company and Golden Cycle Corporation respectively.

Iron Country

Iron-Ore Shipments Well Above 1935

SOME COMPANIES prepare mines for underground operation during winter months

✦ The iron-ore movement continues at a good rate, and if favorable weather continues shipments are expected to equal the rate established in 1930. Predictions by some in the industry indicate that the iron-ore shipments this year may exceed 46,000,000 tons for the Lake Superior district. Shipments to Oct. 1 show an increase of 11,558,375 tons compared with the same period last year.

✦ The Canisteo Mine of the Mesaba Cliffs Mining Company completed ore shipments on Oct. 8 amounting to 1,000,000 tons of washed concentrates from beneficiated ore. The stripping program now under way will continue until about the middle of December.

✦ Butler Bros., who operate the manganiferous Merritt mine, at Trommald, Minn., have a new concentrator under construction to treat the ore by jigs and tables. It is expected the plant will have a capacity of 150,000 tons per year.

✦ The Charleston Mining Company has a heavy schedule and expects to ship about 160,000 tons this season. Operations are carried on at the old Leetonia, Dale, and Cypress mines. The ore is loaded into dump wagons and these are emptied into a receiving pocket in the pit and from this point conveyed by belt conveyor to the washing plant. The operation has interested all mining men and undoubtedly will be adopted at several other properties soon.

✦ The Snyder Mining Company has announced that the Webb underground mine will be reopened and will resume production as soon as possible. This will help the labor situation during the winter months. This company also expects to reopen the Virginia mine, near Eveleth, Minn. A crushing plant is expected to be built and foundations may be poured soon.

HEADFRAMES mark the outskirts of Tombstone, Arizona. The one on the left is over the Empire shaft of the Tombstone Development Company, whose properties have been examined recently. The mine in the foreground is being operated by "leasers"

Arizona

New Custom Ore Plant At Chloride

CAPACITY RATED at 100 tons—Tennessee-Schuykill mill, also at Chloride, now shipping lead and zinc concentrates

✦ The General Ore Reduction Company, of Chloride, expects that its custom plant will be ready to treat ore about Nov. 1. Equipment consists of a 120-hp. diesel generator power plant, a ball mill of 100 tons' capacity, a crusher, an automatic sampler, flotation cells, and other machinery. The capacity of the ore bins at the mill is 800 tons. C. A. Ferrin is president of the company. The main office is in San Diego, Calif. O. T. Dennhardt, of Chloride, is vice-president and in charge of the new construction.

✦ The Tennessee-Schuykill mill at Chloride, is steadily producing lead and zinc concentrates. About 150 tons of ore are being treated daily and a carload of concentrates is shipped to the smelters every third day. The lead concentrates are shipped to the American Smelting & Refining Company's smelter at El Paso, and the zinc concentrates go to the Amarillo smelter, in Texas. The ore is mined from the newly opened stopes on the 900 level in the Tennessee and also taken from the dump of the Schuykill mine. The officers of the company are Henry B. Van Sinderen, of New York City, president; Frank Eichelberger, of Wallace, Idaho, vice-president; P. D. Ash, New York, secretary; E. E. Campbell, of Toronto, Canada, and Judge Carl G. Krook, of Kingman, Ariz., directors. R. L. D'Arcy is mine superintendent and Jacob Schoder in charge of the mill. F. B. Eichelberger, assistant secretary and treasurer, is in charge of the mine office.

✦ The Gold Canyon Mining Company, at Patagonia, is continuing to ship 120 tons of ore each week to the smelter at El Paso, Tex. Recently, more men have been added to the payroll and the ore shipments are expected to be raised to 250 tons weekly. Results from development work are said to be satisfactory, and therefore steady operation on a higher production basis is planned. M. B. Lovelace, of Patagonia, is manager and S. P. Silverman, of 633 San Fernando Building, Los Angeles, is president of the company.

✦ The Edward Smith Exploration Company, of Phoenix, has taken over the Hidden Treasure properties owned by Mrs. Jennie B. Hayes near Cordes. Reports are that a substantial tonnage of ore is already blocked out as well as several thousand tons of dump ore, all of commercial value. The company has the water rights at Dripping Springs. A 4½-in. pipe line brings in the water.

✦ An examination is being made of the Tombstone Development Company's mine at Tombstone by George M. Fowler, consulting engineer of Joplin, Mo., in the interests of the Eagle Picher Lead Company. Negotiations are being made for the purchase of a controlling interest of the Tombstone company as well as an option for working the property, which is one of the largest producers of gold, silver, and lead in the Tombstone district. Ed. Holderness, of Tombstone, is manager. Another operation of the Eagle Pitcher Company in Arizona is the old Montana mine, near Ruby.

✦ Southwestern Metal Mines, Inc., has completed its 50-ton flotation plant and is entering upon a period of regular production. The plant was designed and built by William C. Kinnon, who will remain with the company as mill superintendent. H. P. Moran is president and general manager. This property was formerly known as the French Lily mine. Present improvements have been made possible through an $85,000 RFC loan.

✦ New York interests are understood to have acquired the Colossal group of claims owned by R. E. Logan, of Wagoner, and are making plans for their operation. Considerable mining equipment has already been taken to the property.

✦ Gold Standard Mines Corporation, of Kingman, has four producing properties furnishing ore to its mill at Katherine. The mill is handling approximately 200 tons daily. About 70 per cent of the ore comes from the Portland mine, and the remainder from the Minnie, Arabian, and Philadelphia mines. Richard de Smet is vice-president and general manager.

✦ Oatman Eastern Mining Company, operating the Ruth Rattan properties in the Silver Creek district in Mohave County, is shipping 1,000 tons of ore per month to the Tom Reed mill, at Oatman, for treatment. The Ruth-Rattan has been a consistent and steady shipper for the past year. J. J. Moss is president and general manager of the operating company. F. A. Frazer is superintendent.

✦ A group of 25 claims situated in the north end of the Plucsa Mountains in Yuma County have been optioned by the owner, George Ashcroft, of Bouse, to J. W. Richardson, of Searchlight, Nev. An examination is being made to determine the gold, silver, and manganese possibilities.

✦ The Vivian company is operating the Vivian mines, near Oatman, and has recently installed a new crusher in its plant. The Vivian property has been inactive for a number of years, but had a good production record in pre-War days. T. V. Burton is president of the company, with headquarters in the Kohl Building, San Francisco, Calif.

✦ A. B. Straight, with a crew of men, has started sampling of the old Commercial mine, in the Copper Basin district near Prescott. It is reported that the Arizona Molybdenum Corporation, H. Hendrickson general manager, has taken a lease on the property.

NEWS FROM WASHINGTON

By Special Correspondent

INTERNATIONAL QUESTIONS affecting mining continue to gain in importance and urgency. Washington is more than ever impressive in its talk about world influences when an enterprising reporter can girdle the globe on commercial transport agencies in about eighteen days. This shrinkage of the globe is, in fact, more than ever becoming a basic philosophy guiding administrative plans for mining.

In quite another way, Washington is genuinely impressed as to the importance of world trade relations. Greatly to the Capital's surprise, it is discovered that the much-criticized Hull trade agreements are proving politically more palatable to the Jeffersonian type of Democrat than any other New Deal venture. This probably should not have been as surprising as it seems. Secretary of State Hull, whose unswerving devotion to the cause of lower tariffs conforms with the old-school thinking of conventional Democrats, has merely been using a new technique for the achievement of old-style Democratic purposes.

The real surprise probably will be found in the fact that many business men, as well as professional Democrats, approve of the results. Seemingly a genuine increase in trade opportunity for certain types of manufactured goods has been created. Even though, as critics claim, this is the result mainly of better business conditions, Hull is getting the credit. (Note that it is Hull, not Roosevelt.) From the standpoint of mining, this clearly means that more of the same thing is to be expected for practical business reasons, regardless of political leanings. Perhaps it is not too much to conclude from the current debate that the optimum tariff for any particular industry, like the optimum price for any goods, is not always the highest rate possible.

Power Shortage

Users of power, especially those busy in electrochemistry and electrometallurgical activity, find difficulty in securing enough power at otherwise desirable sites. This has accelerated materially the possibilities of contracts with Tennessee Valley Authority; and it has resulted in three definite contracts during recent months. More negotiations are pending. Other new Government power projects, like Boulder Dam, Bonneville (Oregon), and the rest of the remote locations, are not attracting those industrial bidders whose supplies of raw material, labor, and markets are located principally in the northeastern quarter of the country. Promoters of these Federal enterprises are, therefore, particularly anxious to press those mineral processing ideas which may be feasible of commercialization in the Far-Western and Mountain country.

Those negotiating recently for power in the Tennessee Valley report that supplies of energy there are not "cheap" in the language of big metallurgical users. In several cases proposals which seemingly include very low cost energy, work out to power in large blocks, some of it seasonally unfavorable, at prices of 2.5 to 3 mills. This, according to best present engineering estimates accepted in Washington, is substantially no cheaper than steam-electric power which one may generate where other factors make plant operations most desirable. The over-all cost of a delivered commodity is, of course, properly the governing factor in deciding whether one site is better than another. The nominal power-price schedule, considered alone, often gives the wrong answer to management.

Tax Revision

● Only a miracle can in any way importantly modify the obligation of corporations on March 15, 1937, to report undistributed earnings and pay surtaxes thereon. Even the most optimistic pro-business enthusiasts of Washington do not hope for modification of the tax law of 1936 in time to aid on 1937 returns. November, therefore, is practically a last call for policy decisions of mining companies as to how much of the anticipated total earnings of the year will be distributed to stockholders. The regulations of the Treasury, which have the effect of law, of course, make extra dividends as *pre*-Christmas presents essential if they are to be credited on tax exemptions.

The real battle over this question will come between the philosophies of RFC Chairman Jesse Jones and Treasury-Watchdog Henry Morgenthau. The lender likes to get back his loan, and Uncle Sam is no exception. The tax collector wants generous returns to the Treasury, even if RFC loans are not quite so readily paid off. The White House must ultimately referee the battle between these philosophies.

Copper Forecasts

Anticipated progress has not been made in forecasting demand for copper. Cooperation originally expected has not been feasible, apparently because of the prevailing uncertainty in industry as to the attitude of Government officials on price fixing.

Recent difficulties in forecasting petroleum requirements and gasoline demand show that metal stock-reporting and need estimates will not be easy. Working with the Interstate Compact Committee, Government officials furnish a basis for much needed control of production of crude oil. Some states, more zealous in enforcement of recommendations than others, have actually begun to lose business to non-cooperating neighbors, of which Louisiana is most conspicuous. Thus breakdown of the interstate cooperation is feared.

There will not be analogous interstate troubles with respect to copper, lead, and zinc, for which plans were made some months ago (*E.&M.J.*, July, 1936, p. 360). But in the copper case there is grave question whether the Department of Justice would ignore an operation that would be effective in eliminating surplus production.

Forecasting of demand will inevitably stabilize price. Is this illegal? Does it involve any elements of collusion on the part of those furnishing facts as to present stocks and past sales? Government officials, anxious to furnish the industry with a sound economic basis for management planning, although disappointed at lack of cooperation, recognize these questions as a natural reason for hesitancy.

Mine Labor

Encouraging progress in studies of important factors in technologic unemployment in mining has been achieved by the Government investigators. This work is being carried forward under Dr. David Weintraub, of WPA, with the Bureau of Mines furnishing technical supervision and administrative assistance. (*E. &M. J.*, July, p. 360.)

This project will continue at least until the first of next July. An early report is not expected.

Perhaps most important for the mining industry is the part of the work based on actual surveys of mine machinery installations. This study has been made in conference with equipment manufacturers who have cooperated to furnish data on labor-saving machinery sold, identifying each sale not only by type of equipment but also as to the mine where it was installed. The Bu-

reau records of production by individual mines have permitted a correlation between machinery installations and productivity per man. Also, data are being developed showing the relation between mechanization and the grade of ore mined or mineable.

Officials commenting on this undertaking explain that no one should expect that the results will be useful in planning or forecasting immediate changes in available employment. They will have, rather, a long-time trend benefit. It is futile, they explain, to expect any aid for present stranded mining populations to come quickly from such a fundamental investigation. The benefit will be in preventing the stranding of populations in the future, it is hoped.

Particularly, it is hoped that the results will guide management in deciding when additional mechanization will permit continuance or expansion of a mining enterprise, with the secondary, but very real, benefit in stabilization of employment of workers.

Anti-Trust Problems

It is evident that a more aggressive enforcement of Sherman, Clayton, and Robinson-Patman laws may be expected in the near future. "Cease and desist" orders have been issued by the Federal Trade Commission in a number of cases. The Department of Justice is known to be busy on other problems where Sherman Law violations are charged. "Let the sales manager beware" might be an appropriate motto to post in the offices of mining and mineral companies where price policies are determined.

A series of fundamental tests of the Robinson-Patman Act in the courts is being planned by F.T.C. Apparently, in an entirely straightforward and businesslike fashion the Commission is selecting from the complaints before it those which seem to represent definite type violations of the law. "Cease and desist" orders, followed by prompt court actions, are planned. Business should, and probably will, welcome this procedure in order to define clearly what the courts will approve under this law.

Much less comfort can be found in the forecast of Representative Patman that he intends to press legislation in the next Congress to forbid retail sales by manufacturers. Whether one regards that legislation as probable, or as constitutional if enacted, the threat is very real. And mine managements must recognize that this gesture by Representative Patman is really typical of the present psychology of many who will grace the halls of Congress during the next two years. These legislators seem incurably affected with a peculiar psychological malady. They appear to be quite willing to penalize efficiency under the guise of protecting the public.

Close attention to all new legislation on merchandising is essential for the wellbeing of every industry, regardless of the apparent object of attack occasioning a bill or a speech on the floor. Remoteness from the immediate area of dispute is no protection to the miner. To be convinced of this one needs recall only that the Robinson-Patman law started out simply as an effort of independent wholesale grocers to protect themselves against aggressive competition on the part of chain stores. The final law often, as in this case, bears little resemblance to the initial cause fostered.

Tin Uses

● The consumption of tin for various uses has been investigated by the Bureau of Mines at the request of major consumers. The most comprehensive report on this important strategic material ever issued is in preparation as this news is written. It is being planned for distribution in November.

Officials are also watching closely the current controversy over tin quotas. Quite unofficially it appears to be the hope of Washington that the higher production costs of Bolivia will not be allowed to interfere with generous supplies in the world market at "reasonable prices." Repeatedly, when this question comes up in official circles, there is offered the forecast that if the prices of tin are advanced again, substitution will certainly follow in many important present markets. Also, some are expecting (or perhaps it is hoping) that new tin-plate manufacturing methods will operate to reduce consumption per box of tin plate sufficiently to offset the evident growing consumption of plate for containers.

Uncle Sam, Buyer

Many controversies still rage over the legal status of labor provisions in the Walsh-Healy Act regulating Government purchases. (*E.&M.J.* October, p. 528.) Perhaps the most disputed feature of the first set of regulations released by Secretary of Labor Perkins in September is the definition of open market purchases. Most persons had previously assumed that any commodity commonly bought in the market by competitive bids was so purchased. The Department of Justice rejected the idea and ruled that unless the Government purchasing agent could make such a purchase *without taking bids* it was not an "open-market" transaction within the meaning of the law.

To the surprise of many, the important Government purchasing offices expected to oppose the regulations are finding them of substantial aid in doing business exclusively with the more responsible contractors. The sweatshop type of operator is, of course, greatly handicapped; and even the petty "chiseler" has some difficulties in successfully bidding. The real test of the sentiment of Government purchasing offices will come later. It will undoubtedly prove that this act increases the average cost of certain commodities to the Government. Appropriations hitherto adequate will then be insufficient. It takes no keen imagination to anticipate intra-Government controversies that may put to shame present wails of established contractors.

It should not be expected that rigorous application of this act is likely at all soon to occasion much wage fixing for industry. Months of field investigation must precede any important findings. This does not in any way suspend the nominal effect of the law, but it does at least cushion, perhaps for a year, the impact on wage contracts which some feel will ultimately be superseded in part by rulings of the Secretary of Labor.

Fume Troubles

The mining industry should begin to worry again about "smoke farming." This worry is very rightly inspired by recent ultra-zealous efforts on the part of certain agricultural specialists in Washington. They are advising the Department of State and the American members of the tribunal which is adjusting the Canadian-American problem of indemnity for smelter fumes from Trail, in British Columbia. Unless some interruption to the present course of events can be arranged, the Trail settlements may establish a dangerous precedent for other smelting enterprises in the State.

At least one agricultural spokesman argues that even minute quantities of sulphur are intolerably detrimental to crops. Such extreme view will probably not be officially accepted by the international tribunal. But it has a long leverage on the opinion being built up. Furthermore, it provides a basis for smoke-farming claims elsewhere which probably would not otherwise arise.

Well-informed fact-seeing officials appear to believe that there remain other real problems, both in smelter dust and in sulphurous-gas nuisances. They recognize that managements of important companies are aggressively working on these problems with a view to restricting the escape of gas and dust to a minimum. But even more activity in this direction should be encouraged, they believe.

Utah — Labor Strike Forces Shut-Down of Many Mines

THE UNION DEMANDS higher wages and "collar-to-collar" eight-hour day—Colorado River being tested for gold near Moab

✦ Members of the International Union of Mine, Mill and Smelter Workers, District No. 2, virtually shut off all production of non-ferrous ores in Utah on Oct. 12, when they went on strike for a pay increase of 50c. a day and rigid enforcement of the "collar-to-collar" eight-hour day. Miners at Park City were the first to walk off the job, on Oct. 10. Two days later, every large metal producer in the State, excepting the Utah Copper mine, was forced to shut down.

The strike vote affected all major Utah camps—Park City, Tintic, Bingham, and Tooele, where the International Smelting Company smelter and mill stopped operations. On Oct. 17 the Midvale filtration plant of the United States Smelting, Refining & Mining Company had to shut down because of a cessation of ore shipments. The company's smelter continued to operate in order to handle its clients' ore. A policy of not receiving any "scab" ore was put into effect. Mines and mills of the Utah Copper and the Garfield plant of the A.S.&R. are unaffected.

So far, the strike has not produced any violence. Operators are not attempting to break picket lines with "scab" miners or muckers. Pumpmen and maintenance engineers have been allowed by the union to work. Both miners and operators are apparently digging in for a long siege. Operators contend that wages have been consistently increased as metal price advances have warranted. Miners hold that in view of increased earnings the wage scale should be advanced 50c. daily from $5.25 for miners and $4.75 for muckers.

✦ Placer mining tests are being made in Grand County on the sandbars in the Colorado River, about 10 miles south of Moab. Recently, Clive C. Stewart, of Moab, was granted a lease on the Colorado River bed crossing a 40-acre mineral location in the NW¼ of the NW¼, Section 5, Township 26, South Range 21 East by the Utah State Land Board, on a basis of 50c. an acre and a 12½ per cent royalty. E. H. Burdick, consulting engineer of the State Land Board, reports that gold occurs in sufficient amounts in this area to justify complete and careful sampling. The gold occurs in an extremely fine form. Prospecting on the Chaffin Bar area is being done by Los Angeles capital for the purpose of testing values and using new types of equipment for mining practice on a commercial basis.

✦ The Tintic Prince Mining Company, in the Tintic district, under the direction of L. J. Monter, is drifting from the 340 level of the shaft. Development work has been resumed at the Hassell property, in the West Tintic district, under the direction of David Eager, of Mammoth, on the 100-ft. level of the shaft.

✦ An option on twelve claims belonging to the Silver Shield Mining & Milling Company has been granted to the Tintic Standard Mining Company. Under the terms of the option the Tintic Standard Mining Company is to sink at its own expense, churn-drill holes to a depth of 2,000 ft. close to the ground still held by the Silver Shield Company, but not included in the lease.

✦ Operations will be resumed in the Dagmar property, just north of the Centennial Eureka, according to George H. Adams, vice-president of the company. The shaft will be sunk from the 350- to the 600-ft. level to prospect at depth an outcrop showing good values.

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Quincy Mine Expects Lower Costs

PROPERTY FOUND in fair condition after five-year shutdown

✦ The Quincy Mining Company is employing a few men on repair work preparatory to the reopening of the property in Michigan, which has been closed since 1931. More men will be taken on at mine, mill, and smelter as the work expands. An assessment of $2.50 per share will, it is expected, provide the funds necessary for the resumption of operations. A recent inspection of the property indicates that deterioration underground and on surface during the shutdown period of five years has been relatively small, the largest single item being the replacement of hoisting ropes. Developed reserves of copper ore are estimated to be 2,000,000 tons, and by using the retreating method of mining, costs are expected to be lower compared with those of former years. An additional tonnage of 4,000,000 tons is party developed in the lower levels of the mine, according to the management. Fully 80 per cent of the reserves can be mined through Nos. 6 and 8 shafts. Operations will be confined to these shafts for the present.

✦ Houghton County, in the Michigan copper district, has a total of 2,174 men employed on surface and underground at the mines, according to the annual report of the mine inspector. Of these, 1,292 are on surface and 882 at work underground. Calumet & Hecla and Copper Range are the principal companies operating. Calumet & Hecla has a total of 1,336 employes, and Copper Range, 820.

Tri-State — Bird Dog Mill Improvements

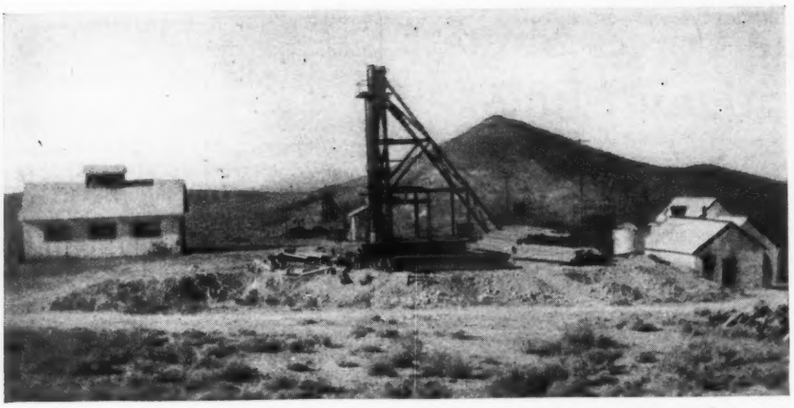
✦ A rapid recovery in the demand for zinc concentrates, which had dropped to a low ebb in July, August, and September, has brought increased activity in the Tri-State zinc and lead district.

✦ The Commerce Mining & Royalty Company is preparing to make a number of changes at the Bird Dog mill which will increase its capacity and efficiency. Thirty-six cells of Mineral Separation flotation equipment are replacing the tweive Butchart float machines now in the mill. A new steel ore bin is being constructed. The ore from the filters will be conveyed by belt to the bin, where it will be weighed by an automatic trip scales.

✦ The Unity mine of the Webb City Lead & Zinc Company, at Oronogo, idle since last July, has been reopened and is sending crushed ore to the Central mill of the Eagle-Pitcher Mining & Smelting Company, according to John Skinner, Webb City, superintendent.

✦ The Webb City Zinc & Lead Company and the Oronogo Mutual Mining Company, combined, are shipping about 1,600 tons of ore daily from the Oronogo district to the Central mill. This tonnage is expected soon to be increased considerably. E. Childress, of Baxter Springs, Kan., is building a derrick and hopper on the Cemetery tract at Oronogo, and Frank Fenix, Joplin, is preparing to construct a derrick and hopper on the LaTosca lease of the American Zinc, Lead & Smelting Company.

✦ Commerce Mining & Royalty Company has completed the sinking of a shaft on the Bennie lease, between Commerce and Cradin, and is now erecting a steel hopper and derrick, according to H. W. Harrison, of Miami, general superintendent. The ore from the Bennie will be hauled by railroad to the Bird Dog mill of the company.



THE GRIZZLY BEAR SHAFT of the Eastern Exploration Company was recently connected with development on the 430 level, where good ore is said to be available. The property is near Goldfield, Nevada, and is under option to the Calumet & Hecla Consolidated Copper Company

Nevada

Sampling Program at Nevada Porphyry Gold Mines

A. O. SMITH CORPORATION determining value of deposit at Round Mountain — Dayton Consolidated acquires lease on the Keystone mine

✦ Surface sampling on a large scale is being conducted at Round Mountain, Nye County, on property of the Nevada Porphyry Gold Mines, by the A. O. Smith Corporation, of Milwaukee, under an option agreement. A 150-ton sampling mill, equipped for this purpose, is supplied by every third shovelful from trenches 24 in. wide and 10 ft. deep excavated by a P&H bantamweight trench-hoe. Similar work was conducted at Manhattan, in the schist area at the south end, but this project is said to have been abandoned. By means of the hoe device it was said that 7,000 ft. of trenches were dug in 75 days.

✦ Late expansion of activities of the Dayton Consolidated Mines Company has involved acquisition, under long-term lease and option, of the Keystone and Woodville-Justice, some three miles up Gold Canyon from the Dayton mine. Ore from the Woodville-Justice area has been treated for some time at the Dayton mill. The Keystone, operated for the past two years by the Comstock-Keystone Company, is to be reopened through the old main shaft. The Dayton Company also has acquired and reopened the Kossuth mine, at the south, and is now active in the Garden Valley district on the California Mother Lode, reopening three old mines. Homer L. Gibson is executive head of the Dayton company.

✦ Equipment of a newly constructed 25-ton mill at the Austin family's Jumbo mine, in the Awakening district, east-central Humboldt County, has made a test run and is ready for continued operation on gold ore of uniformly high mill grade, mined from a series of tunnels in schist. Equipment includes a jaw crusher, a ball mill, amalgamating "gold traps," and a Wilfley concentrating table. Sorted high-grade ore is still fed to a 2-ton plant. More than 600 claims have been filed upon in an area 10 by 5 miles in extent along the slopes of the Slumbering Hills range, in which the Austin mine, after many years of sporadic prospecting, has been the only important discovery. Three compressors have been provided on adjacent groups, optioned to California and Utah men. Desert roads leading to the new district are discouraging to travel, but large numbers of cars continue to make the trip, despite deep dust and high centers. Some abatement is to be noted in the wild-eyed publicity to which writers for papers and magazines from both East and West have contributed. No authentic report is yet available of any discovery of proved value on ground other than that embraced in the Austin mine.

✦ Vanadium ores found in the western part of the Yellow Pine district near Goodsprings, southern Clark County, are to be treated in a concentrating plant nearing completion at Sandy, near the Nevada-California line. Vanadinite has been found at several points in this area, and a small production of shipping ore was made some years ago. The vanadinite in some instances is combined with wulfenite.

✦ Following recent sampling, the Haystack mine, near Haystack Peak in northern Pershing County, formerly productive of high-grade gold ore, has been acquired by the newly organized Jungo Gold Star Mines Company, headed by C. D. Terwilliger, prominent lumber man, and Reno associates. Sampling was conducted by S. H. Brady, formerly of Tonopah. The mine, idle for some years, was acquired from George B. and Jesse Austin, chief owners of the rich Jumbo gold mine, northeast of Jungo.

✦ In the Eldorado Canyon district, Clark County, 17 patented claims and the Duncan amalgamating mill have been purchased by the Eldorado Rover Mining Company, of which P. A. Keegal is president and managing director. The mill has been enlarged and a sampler is being provided to handle custom ore. A pipe line from the Colorado River, with two booster pumps, will provide the water supply.

✦ Lode and placer mines of the Osceola district, 35 miles southeast of Ely, in White Pine County, are again becoming centers of activity. The Eastern Nevada Mines, Ltd., an association of three men, is providing equipment to mine and ship high-grade gold ore from a wide zone of shattered, gold-bearing quartzite exposed along the crest of a ridge above the placer area and which can be mined to advantage by power shovel. B. T. Ritchie is managing director in charge.

✦ Eastern Exploration Company, a subsidiary of Calumet & Hecla Consolidated Copper, continues occasional carload shipments of gold ore, reported as high-grade ore mined from properties of the Goldfield Consolidated Mines Company and Goldfield Deep Mines Company, under lease and option of purchase.

Colorado

Operators Solve Tailings Disposal Problems

✦ United Gilpin Company, at Central City, under the supervision of G. F. Kremm, is milling between 500 and 600 tons of ore per day. Some custom ore is also treated in the plant. Higher-grade ore and low mining and milling costs have made operations profitable for the company. The tailings-disposal problem has been solved by the purchase of additional land, which will be used for this purpose.

✦ American Smelting & Refining Company, at Leadville, is providing additional roasting and sintering capacity to take care of the increasing supply of concentrates coming out of the district.

✦ The London Mines Company, at Alma, has recently constructed a well-designed tailings-disposal dam. The coarser tailings are sent through launders and emptied around the edge of the dam, where the material falls onto the slope where cut trees and brush act as rein-

Engineering Curricula Accredited by ECPD

AS A RESULT of its first year's work in the New England and Middle Atlantic States, the Engineers' Council for Professional Development has announced the accrediting of certain engineering curricula by its Committee on Engineering Schools. Of special interest to the mining industry is the recognition extended to the following institutions:

In Mining Engineering: Columbia University, Lafayette College, Massachusetts Institute of Technology, and University of Pittsburgh.

In Metallurgical Engineering: Carnegie Institute of Technology (day and evening curricula), Columbia University, Lafayette College, Massachusetts Institute of Technology (metallurgy), University of Pittsburgh, and Yale University.

The work of the Committee on Engineering Schools will be extended this academic year to the other regions of the United States which contain more schools of mining and metallurgy than exist in the Eastern areas.

forcing material. Slimes are pumped to the dam and flow to the center of the pond. The outer wall is built up in the summer and early fall, so as to provide sufficient room for all tailings disposal during winter operations. The mill is treating about 160 tons of ore a day, and the method of tailings disposal is said to be operating very satisfactorily. H. L. Tedrow is general superintendent.

✦Leadville Metal Milling Company is treating 450 tons of oxidized ore per day, which is taken from the old Ibex dump. This is said to be the only flotation mill treating oxidized ore exclusively in the State. Its supply of this class of ore in the Leadville district is said to be large. L. S. Harner, general manager, is also general manager of the Cripple Creek Milling Company.

✦ The Treasure Mountain Gold Mining Company, of Silverton, announces plans for operations at the San Juan group of claims on Treasure Mountain. The Santiago tunnel will be extended to permit deep development of the San Juan Queen, Vanderbilt, Scotia, Justice, and the Atlantic-Watseka veins. Guy L. V. Emerson is president.

✦ The Boulder Mill, at Salina, Colo., operated by T. Scott, has sufficient custom ore to operate throughout the winter.

THIS GOLD NUGGET, recently discovered in Idaho, has a striking resemblance to another product well known to that State—potatoes. It was found in the Murray gold district and its estimated value is $550. A smaller one valued at $150 was also recently reported found in the same district

Idaho

Callahan Lead-Zinc Company To Unwater Galena Shaft

VULCAN TUNNEL to be advanced —Ten men killed in Morning mine shaft

✦ The Galena mine of the Callahan Lead-Zinc Company, control of which recently passed into the hands of Frank Eichelberger and Eastern associates, is now being subjected to an active mine-development program. The 1,600-ft. Galena shaft is being unwatered and new development will follow along the vein, which has produced a large tonnage of ore in past years. On the other side of the hill the Vulcan tunnel will be advanced 2,000 ft. to prospect silver-bearing veins.

✦ The Coeur d'Alene mining district was visited by an unfortunate accident on the morning of Oct. 6. Ten miners lost their lives when the flat rope attached to a double-deck cage broke in the shaft of the Morning mine of the Federal Mining & Smelting Company at Mullan. The accident occurred at the 3,050-ft. station, where four men had stepped into the cage to join six others brought up from the 3,450 and 3,250 levels. The cage tender had given the signal to lower the cage to permit men to step on the upper deck, and as he opened the door for the men to enter the rope broke about 1,200 ft. above, and the cage containing the ten men dropped 900 ft. to the bottom of the shaft. The broken rope, estimated to weigh about 4,000 lb., followed the cage down the shaft and crashed on top of the cage, which had shot through the bulkheads. A coroner's jury, State Mine Inspector Arthur Campbell, Coroner Herbert Mowery, General Manager H. G. Washburn of the Federal company and other officials, all investigated the accident. After hearing the evidence from a number of witnesses the jury returned a verdict of "unavoidable accident." The ten men who lost their lives were Andrew Kese, 54; August Siponene, 48; Henry McGowen, 39; Lewis Goff, 25; Carl Donaldson, 24; Jerry Phelan, 28; Cleo Purcell, 29; Rex Micheletta, 27; William Buchanan, 22; and Elmer Woodworth, 46. J. E. Berg, mine superintendent, testified at the inquest that the cable, a flat type, $\frac{3}{8}$ in. thick and $4\frac{1}{2}$ in. wide, had a breaking strength of approximately 72 tons. The estimated load when the cage fell was 11,709 lb., including 2,300 ft. of cable strung out to the 3,050 level. "This load meant that there was a 12 to 1 margin of safety when the cage fell," said Mr. Berg.

✦ The Murray gold district yielded another large gold nugget last week when Charles Lofan and Emmett Allan, working on the Beehive claims, uncovered a chunk of gold weighing about five ounces and worth $150. The nugget was found a short distance from the spot where Jim Clark, of Enaville, rolled out one worth $550 a few weeks ago, Clark's find being shown on this page.

✦ Preparations for the construction of the new 300-ton flotation mill for the Polaris-Chester group of mines is well under way. W. L. Zeigler, Hecla mill superintendent, is in charge of the construction. This will mark the third mill for the silver belt of the Coeur d'Alenes, the other two being the Sunshine and Crescent, both modern flotation plants.

Canada

Canadian Mining Institute Convenes at Vancouver

WESTERN MEMBERS of A.I.M.E. sponsor talks on silicosis—Heavy rains delay construction of power dam for current at Big Missouri

✦Over three hundred mining men from all parts of the Province and many other points in the Dominion and the United States gathered in Vancouver on Oct. 7 to 10 for the annual meeting of the B. C. Division of the Canadia Institute of Mining and Metallurgy, and for the first time the western sections of the American Institute collaborated. Among the many prominent visitors were the Dominion Minister of Mines, the Hon. T. A. Crerar; the Minister of Mines for Manitoba, the Hon. J. S. McDiarmid; the Minister of Mines for British Columbia, the Hon. George S. Pearson; the Lieutenant Governor of the Province, the Hon. E. W. Hamber; the president of the Institute, Lieut.-Col. George E. Cole, of Winnipeg; and the general secretary, E. J. Carlyle, of Montreal.

Addressing the annual dinner, the Minister of Mines for Canada spoke optimistically of the future of the industry and reiterated the promise of the Cabinet not to increase mining taxation during its term of office. The concluding technical session was under the sponsorship of the American guests, and was presided over by Dean Milnor Roberts, of the University of Washington. Silicosis was the subject of papers by two San Francisco men, Edward J. Bloom and G. Chester Brown. Mr. Bloom declared that in California silicosis is a racket of colossal proportions, fostered by political groups and other interested parties, including some medical and legal men. He said that as even the medical profession was not certain of the nature of the disease, it was presumptuous to attempt to dictate its control and compensation by legislation. Local speakers denied that silicosis is likely to become a racket in British Columbia. Earlier in the proceedings, the president of the Mining Association of British Columbia, T. W. Bingay, indicated that legislation would probably be introduced at the forthcoming session of the Provincial Legislature amending the Workmen's Compensation Act.

✦In the Portland Canal district, the construction of a dam to harness power for the proposed 500-ton underground mill at the Big Missouri has been delayed by torrential rains, which washed away a cofferdam. Its reconstruction has been commenced. Work at the Silbak-Premier consists in cleaning up the old workings and exploring the former B. C. Silver property.

✦Mines, Ltd., a Bahamas corporation, has acquired control of the old Surf Inlet and Pugsley mines, on Princess Royal Island, 400 miles north of Vancouver, and have reconditioned part of the old 300-ton plant, which is now treating 40 tons daily. P. W. Racey is engineer in charge.

✦At the Pioneer, production is lower because of the heavy development program now in progress in the new low levels. In September the output was valued at $188,000, the lowest for any month this year. Expenses were approximately $77,000. The main vein has been opened at the 23d level for several hundred feet, with satisfactory widths and values, according to A. E. Bull, vice-president. A new two-stage crushing plant is being installed.

✦The outlook for mining in the Similkameen district is more promising than for many years. Granby Consolidated has obtained a court order staying liquidation proceedings in order to resume operation of its Copper Mountain mines and 2,500-ton concentrator at Allenby. Before work was suspended in 1930 owing to the low price of copper, 600 men were engaged in the enterprise. Plans are also being made to construct a 50-ton flotation mill at the Gold Mountain. At the old Nickel Plate mine, now owned by Kelowna Exploration Company, Ltd., about 225 tons a day is being milled.

Quebec

✦The Noranda Mines, Ltd., is planning to spend $5,000,000 in the near future for the development of its own power. Following the approval of the Quebec Government of certain details, contracts for the construction are expected to be let. The capacity of the project is said to require 30,000 hp.

Mexico

Government Railroads for Western Mining Districts

LINE IN NORTHWEST MEXICO will connect with Ajo, Arizona—Labor difficulties continue

✦Mid-fall found the Mexican mining industry somewhat more active, with the Government taking more direct action by planning increased work in the Cerro Colorado reserve, Oaxaca, and expanding Federal mineral zones. Railroad construction, already under way, will benefit the industry in several regions by affording more adequate transportation facilities. Labor troubles continue. Though most of these were settled, the most important of all, the strike that closed the Morales unit, San Luis Potosi, of Asarco, still continued.

✦Mining, especially of gold, silver, iron, and antimony, will be stimulated by a railroad the Federal Government is building between Ixcaquixtla, Puebla, and Chacahua Bay, on the Pacific coast of Oaxaca, a distance of 310 km. A branch line 160 km. long is to service a great mining zone. Northwestern mining will be greatly benefited by the railroad the Government has started between Fuentes Brotantes, Lower California, and Punta Penasco, Sonora, which is to have a branch that will connect with the Southern Pacific Railway of Mexico and link with American lines at Ajo, Ariz. Both railroads are to be finished by 1940. Cia. Fundidora de Fierro y Acero de Monterrey, S. A., operating Mexico's greatest iron and steel works at Monterrey, Nuevo Leon, is working overtime filling an order for a large number of steel rails for Ferromex, the semi-official railroad construction firm.

✦Cia. Minera Minas del Tajo, S. A., Rosario, Sinaloa, resumed work after a fortnight's shutdown resulting from the cyclone that swept the town, putting two electric generators of 1,000 h.p. each out of commission. The company suffered most of the loss, which totaled about 1,000,000 pesos (about $280,000).

✦Intervention by the Federal Labor Department ended a labor dispute that threatened a strike at the San Luis Mining Company, in the Tayoltita zone, Durango.

✦Nearly 8,000,000 pesos (about $2,230,000) in gold has been recovered by prospectors during the past year from placers at El Tiro, Altar district, Sonora.

✦American Smelting smoothed out labor troubles at its Huicicila unit, Nayarit, by canceling its proposition to reduce the work week there by two days and instead the company laid off 85 sick miners, allowing them full indemnification, a plan the miners' union accepted.

✦A presidential decree provides that all free lands in Mexico containing aluminite shall be incorporated in the Federal mining reserves.

✦The Guanacevi Mining Company settled a labor dispute at its Guanacevi

property, in Durango, by making contracts which grant higher wages, together with other economic concessions.

✦ American Smelting & Refining has increased wages of its Chihuahua units' workers from 12½ to 25 per cent.

✦ The Ministry of Finance was ordered by the national Supreme Court to refund to American Smelting 120,000 pesos (about $33,600) it collected in 1931 as income tax. The tribunal held the collection to be illegal.

Gold-Bearing Iron Deposit Will Be Exploited

✦ Norseman Gold Mines, N. L., has acquired the Iron King mine, three miles south of Norseman, W. A. The lode comprises an auriferous ironstone bed 50 ft. thick and at least 800 ft. wide. The deposit will be mined by the open-cut method and the ore treated by the cyanide process, which will give a good recovery, and costs should be low. Sampling of the open cut shows a large tonnage assaying 3½ dwt. per ton. The company plans to treat 1,500 tons monthly from the Iron King at its own plant.

✦ Reedy Creek Alluvials, Ltd., is being formed by Beechworth Alluvials, N. L., to carry out sluicing at Reedy Creek, near Beechworth, Vic. The property has been proved to contain 5,250,000 cu.yd. to an average depth of 21 ft. With working costs at 8.5d. per cubic yard and tin and gold at present prices, the net profit is estimated at £10,800 per annum. A sluicing plant, with a capacity of 20,000 cu.yd. monthly, is to be installed at a cost of £8,000.

✦ The 14-cu.ft. bucket dredge to be installed by Wellington Alluvials, Ltd., on the Macquarie River, N. S. W., will weigh about 2,600 tons and will be the largest ever operated in Australia. The property consists of thirteen dredging leases covering a length of nine miles along the river. Testing has revealed an estimated dredgeable quantity of 38,000,000 cu.yd., with an estimated recovery of 7½d. per cubic yard with gold at £4 (Australian) per fine ounce. The question of installing a second dredge is under consideration. Wellington Alluvials, Ltd., which has been formed by Broken Hill Proprietary, has a capital of £250,000 in shares of $2 each.

✦ For the four weeks ended Sept. 2, Mount Morgan, Ltd., treated 25,000 tons assaying 3.70 dwt. gold per ton and 0.66 per cent copper. The new oxidized-ore treatment plant will be in operation in November and will treat 6000 tons weekly. At least 1,500,000 tons of oxidized ore assaying 2.3 dwt. is available.

✦ Dr. Loftus Hills, consulting mining geologist, has expressed the view that the Yanawai gold field, on the island of Vanua Levu, Fiji, may rival in importance the Tavua gold field, on the island of Viti Levu, Fiji. Payable ore has been found to extend from the Mount Kasi mine, near the Yanawai River, for a length of three miles. Barytes is a prominent constituent of the gold ore on the Yanawai gold field.

✦ H. J. C. Conolly, consulting geologist of Emperor Mines, Ltd., has estimated that ore reserves of the Emperor mine are 720,000 tons. Developed oxidized ore aggregates 620,000 tons and telluride ore 50,000 tons. Partly developed ore, consisting principally of telluride, is 50,000 tons. The grade of the oxidized ore is given at 10 dwt. and that of the telluride ore is reported to be higher. These estimates do not include any ore from the Regent lode. The Emperor mine is to be equipped with a cyanide plant with a capacity of 12,000 tons monthly.

Tungsten Ore Shipped From Southern Rhodesia

✦ Production of scheelite has been started in the Bulawayo district of Southern Rhodesia, and an initial shipment of 10 tons, assaying 72 per cent tungstic oxide, has been received in England. It is said that there are other deposits in the district than that from which this shipment was obtained. An early expansion of the operations is expected.

✦ Roan Antelope reports an operating profit for the year to June 30 of £771,402 from the production of 50,672 long tons of copper. The average of prices received for its output was £34.581 per long ton. A net profit of £514,487 remained after interest replacements and obsolescence (depreciation) and London expenses. The report says work is proceeding on the completion of a 1,000-ton test unit and a new concentrate thickener tank. Changes in metallurgy made during the year, together with a dust-collecting system and other minor additions to smelter equipment, resulted in improved recovery. The Storke shaft, raised and timbered from the 820-ft. level, has been provided with a permanent steel headframe, and sinking below that level is in progress.

✦ Mufulira Copper Mines, Ltd., (of whose capital 64.07 per cent is owned by Rhodesian Selection Trust, Ltd., and the remainder by Rhokana Corporation and the British South Africa Company) made an operating profit of £297,562 during the year to June 30. It is expected there will be further capital expenditures during the present year of approximately £128,000, this paying for the installation of a central pumping plant underground, a fine-crushing plant, and various surface construction. Extraction of ore was confined to the three orebodies above the 460-ft. level, and so much ore came from just under the leached capping that the mill feed contained 0.77 per cent of copper in oxide forms.

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Gold and Tin Mining Activities in British Isles

✦ Another attempt is to be made to develop a gold mine in the British Isles, this time in North Wales. The North Wales Gold Company has been formed, with £100,000 capital. Its purpose is to acquire shares in Cheltenham Investment Company and also mining rights in Wales and elsewhere.

✦ The resurrection of old tin mines in the Cornwall district of England is proceeding and seems likely to continue. Though productive operations are on a small scale and at only a few mines, they are generally yielding profits. One of the most ambitious undertakings is that of unwatering and developing several adjacent mines by Great Work Tin Company. The work is revealing shoots of ore which assay approximately 30 lb. of black tin per ton over widths of 3 to 4 ft.

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Spain

✦ Rio Tinto Company, despite the conditions of uncertainty prevailing in Spain, is paying the usual semi-annual dividend on its 5 per cent preference shares. The latest advices from Spain state that the miners have returned to work since the area was captured by the insurgents and that the mines had not been interfered with.

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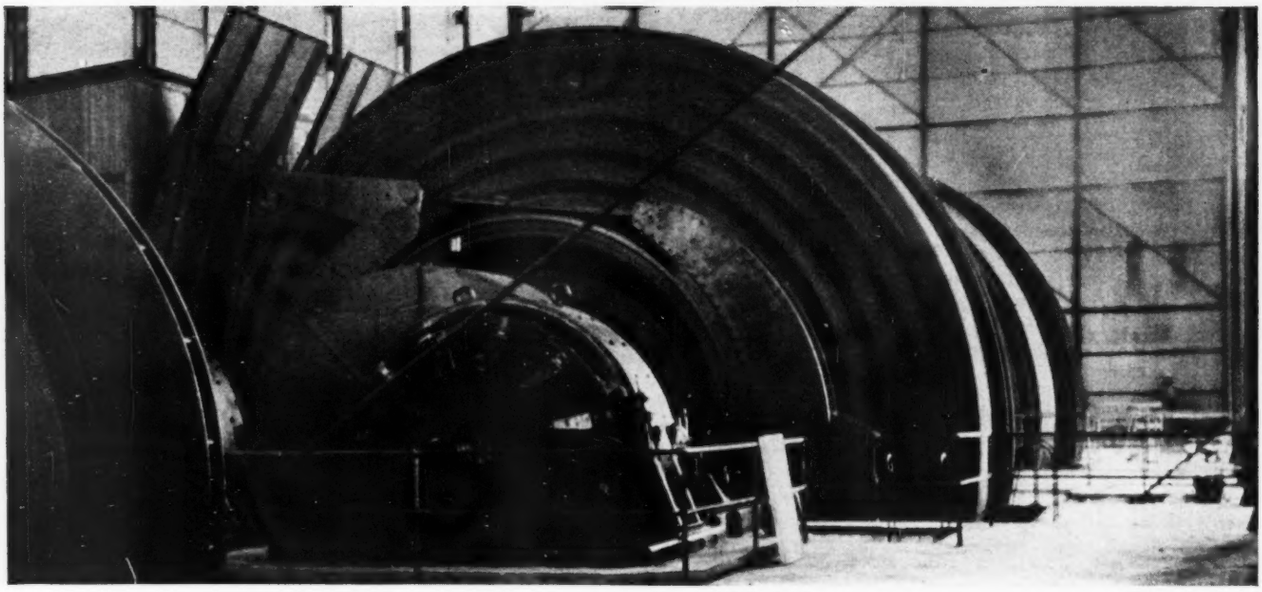
China

✦ Following protracted negotiations through International Investments, Ltd., a Hongkong British syndicate has secured rights to operate the Lin Ma Hang mine, which is situated in the British New Territory close to the Chinese border. Engineers report that considerable development work has already been done and existing ore reserves containing gold, silver, lead, and zinc warrant the construction of a 100-ton flotation plant. John France Manning has been appointed consulting engineer for the Hongkong British syndicate and has started his examination.



THIS HOIST DRUM ON THE FAR EAST RAND winds cable over a 145-ft. headframe situated over a vertical shaft which is being sunk to a depth of 4,500 ft. The drum diameter is 37 ft. and is considered the largest in the world. It is installed on the property being developed by Vlakfontein Gold Mines. Among its records this company lists sinking the shaft 422 ft. last March, using 93 blasts. The shaft contains six compartments which cover 600 sq. ft., which is also considered a world's record.

South Africa

Ground Broken for First Shaft on Far West Rand

GOLD PRODUCTION From Lupa field and the Congo increasing

✦Of more than usual interest as regards the future of the Far West Extension of the Witwatersrand gold-bearing beds was the ceremony, performed recently, by Sir Ernest Oppenheimer, chairman of the Anglo-American Corporation and De Beers, Ltd., of cutting the first sod of a shaft to be sunk on the new lease area acquired from the Government by Western Reefs Exploration & Development Company, Ltd. The farm on which operations were started lies to the south of the Town lands of Klerksdorp—a settlement which in the past played a prominent part in the gold-mining development of the Transvaal. It must be a matter of great satisfaction to the company, after several years of pioneering work in its field, which is about 75 miles from the existing gold mines of the Witwatersrand, to know that its initiative has been rewarded by the granting of a lease by the Mining Leases Board on a large area on liberal and favorable terms.

✦A steady increase in gold production from the Lupa gold fields of Tanganyika Territory, East Africa, reached a peak figure of over 1,100 oz. per week during April, according to R. A. Mackay, Inspector of Mines. Though production has come mostly from alluvial sources, the small reef mines are now contributing an important proportion of the output, which is expected to increase substantially. Whereas last year approximately 42,000 oz. were produced, this year's figures will be higher. For the first six months of 1936, 7,830 tons of reef ore were treated, yielding 3,106 oz. Most of the orebodies are quartz veins, in gneisses and diorites, occurring in shear zones or fissures, occasionally along contacts. The area is at present essentially a small-workers' field. Of some 100 recorded properties, 28 have reached the stage at which they show possibilities of becoming small-workers' mines. Twelve are now producing. There being no arsenic or antimony, and copper in only a few occurrences, the ores cannot be said to be complex. The largest property on the field is Saza, of the East African Goldfields, Ltd., which has not yet come into production. This company intends to erect in the near future a pilot plant of about 100 tons' capacity a day, ample ore reserves being already available. Labor, power, and transport potentialities on the field are good. The labor supply is plentiful and cheap, the cost per native worker being $3.50 a month, including rations. After the completion of a road, now under construction, transport costs from the coast to Lupa will be a little over $40 a ton for machinery in 10-ton lots or over.

✦The following gold productions, in kilos, during 1935 are reported for the Congo companies named. Figures in parentheses refer to the previous year, according to the report of the Government Mining Engineer, published in September, 1936: Compagnie Minière des Grands Lacs Africains, 1,846 (1,586); Union Minière, 526; Société Symor, 132 (53); Société Syluma, 143 (74); Société Kinor, 230.3 (195.8); Sombia, 345.4 (290.5); Comité National du Kivu, 63.5 (47.8); Compagnie Minière de l'Urega, 7.8 (77.2); Société de l'Aruwimi-Ituri, 381.5 (300); and Société Minetain, 223 (240).

✦Though it is well known that South West Africa is a large producer of diamonds, it is not so well known that certain deposits in the Territory contain rare and valuable semi-precious stones. Unfortunately, the market for these stones has not recovered from the effect of the depression, with the result that no production takes place at present. Besides the gem varieties of beryl, beautiful green and red tourmalines, crystal-clear topazes, and transparent purplish-red almondine garnet occur, all of which cut and polish with pleasing effect; and deposits of rose quartz, associated with the beryl-bearing pegmatites, were worked in former years.

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Foreign Copper Producers Agree to Raise Output

Foreign copper producers participating in the curtailment agreement announced on Oct. 26 that production by the group would be increased 10 per cent, to 95 per cent of capacity, on Nov. 1. This latest increase in production, the fourth consecutive rise in output by the foreign group, will establish the rate of operations of the Chilean and African mines at 95 per cent of capacity. The increase over the 85 per cent rate, in force since Oct. 15, is expected to yield an additional 7,000 tons a month in foreign mine output.

PERSONAL ITEMS

A. W. Allen is leaving Ecuador in November.

Edgar Sengier, managing director of Union Minière du Haut-Katanga, has been visiting New York.

Carl Frederick Dietz announces the removal of his consulting engineering offices to 120 Broadway, New York City.

C. Leslie Bruns and **Leonard E. Losey** sailed from Seattle for Manila on Oct. 24 to join the technical staff of the Fairchild interests.

C. George McCullagh, who is on the board of the Mining Corporation of Canada, has become a member of the board of governors of the University of Toronto.

T. V. Barton, president of Vivian Mining Company, has recently been in Mojave County, Calif., where the company is operating its mines near Oatman. New crushers have recently been added to the mill.

Joshua Green, of Seattle, Wash., has been elected a director of Sunshine Consolidated Mining Company, operating on Beaver Creek, Shoshone County, Idaho, to fill the vacancy caused by the resignation of Frank Eichelberger.

George M. Fowler was married on Oct. 5, at Evanston, Ill., to Miss Lois Grant, thus keeping among the geologists one whose father, grandfather, granduncle, two uncles, and a cousin or two have followed the profession.

James E. Moore recently returned to Oakland, Calif., from an engagement with the Bremner Mining Company, at McCarthy, Alaska, and has been engaged by the Nevada Lucky Tiger Mining Company, Winnemucca, Nev., as manager.

W. A. Wood, consulting engineer of New York City, recently returned with a staff of engineers from Plzen, Czechoslovakia, where he performed special work in connection with copper and brass fabricating plants for the Skoda Works.

A. P. Fawley, who attended Queen's University, at Kingston, Ont., last year on an exchange scholarship, after working underground last summer at the Pioneer Gold mine, in British Columbia, has entered British Columbia University for his final collegiate year.

John Knox, Jr., has been appointed manager of Francoeur Gold Mines, Ltd., which is operating a property in Boischatel Township, Quebec. He had, prior to assuming his present post, for some years been president and manager of Minto Gold Mines, Ltd., at Wawa, Ont.

Dr. Robert M. Dickey, of the University of Wisconsin, has been named head of the department of mining and mineralogy at the Michigan College of Mining and Technology, at Houghton. Dr. Dickey was formerly consulting engineer to the Ogelbay-Norton Company.

Walter M. Dake, since 1924 consulting engineer in charge of sales with the Joy Manufacturing Company, of Franklin, Pa., has resigned from the staff of the Joy company to join the mining publications group of the McGraw-Hill Publishing Company as manager of research activities for the editorial and business departments of *Engineering and Mining Journal*. Mr. Dake's early engineering experience, which began in 1903, was in metal mining and public utility fields in California, Colorado,

WALTER M. DAKE

Nevada, Utah, and Mexico. He was associated with Goldfield Consolidated, Nevada Hills Mining Company, Pitts-Silver Peak G. M. & M. Company, United States Smelting, Refining & Mining Company, and Aurora Consolidated Mines Company. In 1921 Mr. Dake organized the Dake Engineering Company, at Denver, Colo., an association of mining, civil, electrical, oil, and mechanical engineers for general consulting work. He is a member of a number of engineering societies, includnig the A.I.M.E., the American Mining Congress, and the Engineering Society of Western Pennsylvania. He has contributed to technical papers articles on the cyanidation of gold and silver ores and on the problems involved in successful mine mechanization.

Harlan A. Walker has been appointed assistant general manager of El Potosi Mining Company, Mexican subsidiary of the Howe Sound company, at Chihuahua, State of Chihuahua, Mexico. **J. B. Croze** has been named superintendent, having been general mine foreman prior to his recent appointment.

Dr. Walter S. Landis, of the American Cyanamid Company, received the award of the Chemical Industry Medal for 1936 on Nov. 6 at a joint meeting of the American Section of the Society of Chemical Industry and the American Chemical Society, held at the Chemists' Club, in New York City.

Lawrence B. Wright and **Samuel H. Dolbear** announce the organization of the firm of Wright, Dolbear & Company, Ltd., consulting mining engineers and geologists. **H. Foster Bain** will be associated with this firm. The New York office will be at 17 Battery Place.

Dr. Charles Camsell has been appointed Deputy Minister of the recently organized Federal Department of Mines and Natural Resources of the Dominion of Canada. **John McLeish** has been named as director of the mines and geology division of the department.

Karl M. Stewart, formerly general superintendent of the I X L Mining Company, has joined the staff of L. R. Nielson & Company, and will be general superintendent of Paracale Gold Mining Company, of Paracale, Camarines Norte, P. I., which is being operated by the Nielson interests.

George Weinhagen, Jr., of Milwaukee, accompanied by **Harvey L. Weber** and **J. Hone,** of Arrow Airways, recently completed a trip by air across northern Manitoba, in the course of which they visited Island Falls, Gurney Gold Mines, Wabouden, God's Lake Gold Mines, and Laguna Gold Mines, at Herb Lake.

H. W. Gould, of H. W. Gould & Company, Mills Building, San Francisco, recently examined a new quicksilver discovery near Minto, British Columbia. The Manitou Mining Company, which is working the property, has developed sufficient ore to justify installation of a plant, which will probably be put in this winter.

Frank L. Hess, of the United States Bureau of Mines, has returned to the offices of the Bureau at 105 Arts and Science Building, College Park, Md., after a month's vacation in the Black Hills of South Dakota, during which period he conducted a series of geological examinations into problems that have long engaged his interest and attention.

Wendell W. Fertig, formerly general superintendent of the Old Hundred Gold Mining Company at Silverton, Colo., has accepted the position of chief engineer and geologist with the Baguio Gold Mining Company, Baguio, Philippine Islands. He has had a wide and varied mining experience with the Arizona division of the Nevada Consolidated Copper Company, the American Mining Company, of Alma, Colo., and the Shenandoah-Dives Mining Company of Silverton.

Oscar N. Friendly, vice-president and general manager of Park Utah Consolidated Mining Company, of Salt Lake City, Utah, has been elected chairman of the board of governors of the Western Division of the American Mining Congress. Mr. Friendly succeeds the Hon. Jesse F. McDonald, of Denver, formerly Governor of Colorado and president of the Down Town Mines Company. The full board is composed of distinguished metal-mining men from Western mining states and from Alaska.

Erskine Ramsay, of Birmingham Ala., chairman of the board of the Alabama Byproducts Corporation, was awarded the W. L. Saunders Gold Medal for 1937 by unanimous vote of the board of directors of the A.I.M.E., on Oct. 15. The medal is awarded annually for "distinguished achievement in mining." Former recipients include Herbert Hoover, John Hays Hammond, D. C. Jackling, W. H. Aldridge, Pope Yeatman, James MacNaughton, and Clinton H. Crane.

Ralph Shimmin, superintendent for the past year for the San Juan Metals Corporation, has resigned his post and accepted a position with the American Smelting & Refining Company at the Azurite mine, in Washington. **Edward Ress** has been named to succeed him as superintendent.

George W. Coffee, general manager of the Yukon Gold Company, at Ampang, Selangor, F.M.S., and **A. M. Peterson,** manager of Pato Consolidated Gold Dredging Company, Baranquilla, Colombia, S. A., are in San Francisco on vacation.

S. E. Stein, sales engineer of the Southwestern Engineering Company, has left Los Angeles for the Philippine Islands. He expects to stay in the Orient for several months, and can be reached at 221 National City Bank Building, Manila, P. I.

W. S. Reid, until recently superintendent at the lead smelter of the American Smelting & Refining Company, Murray, Utah, is now at the company's plant at Selby, Calif.

A. V. Udell has resigned his position as manager of the properties of the Pacific Mining Company at Bagby, Mariposa County, Calif. He is succeeded by **Phillip Bradley, Jr.,** Crocker Building, San Francisco, Calif.

Thos. D. Harris, general manager of Bulolo Gold Dredging Company, Ltd., has returned to New Guinea after several months' vacation in California.

H. Robinson Plate, consulting engineer, has opened an office at 58 Sutter St., San Francisco, Calif.

Leslie V. Waterhouse, technical director of Bulolo Gold Dredging Company, Ltd., returned to Australia in October.

Dr. J. K. Gustafson, formerly on the staff of Western Mining Corporation, Western Australia, is now engaged in an examination of the Broken Hill lode.

Sir Herbert Gepp, formerly general manager of the Electrolytic Zinc Company of Australasia, Ltd., recently resigned the position of consultant on development to the Commonwealth Government.

J. N. Ong, mill superintendent of Mufulira Copper Mines, Ltd., of Northern Rhodesia, has returned to South Africa after a long stay in the United States.

Earl G. Bowen was reelected president of the Sierra Gaston Gold Mining Company at the annual meeting of stockholders held in September. **T. F. McIntyre** and **G. S. Hanna** were reelected vice-president and secretary-treasurer. The executive office of the company is at 251 Acton Place, Oakland, Calif.

E. H. Gould, consulting mining engineer of Battle Creek, Mich., is examining gold properties adjacent to the Climax mining district in Summit County, Colo.

J. J. Lillie has left his position as general superintendent of the Walker Mining Company to become manager of Mountain City Copper Company and assistant general superintendent of mines for the International Smelting & Refining Company, with headquarters in the Kearns Building, Salt Lake City, Utah.

C. F. Dandois recently moved from Florence, Colo., to Alma, Colo., where he is employed by the London Gold Mines Company as mill superintendent.

John France Manning, a mining engineer with more than 30 years' experience in the Far East, has been engaged as consulting engineer by International Investments, Ltd., a Hongkong British syndicate, to make an examination of the Lin Ma Hang mine, situated in British New Territory close to the Chinese border.

P. M. Arthur, of the American Zinc Company of Tennessee; **John L. Boardman,** of Anaconda Copper Mining Company; **H. T. Harper,** of Tennessee Copper Company; and **H. C. Henrie,** of Phelps Dodge Corporation, have been selected to be members-at-large of the mining section of the National Safety Council, 1936-37. **Angus D. Campbell,** of McIntyre Porcupine Mines, Ltd., has been named vice-president in charge of membership of the mining section executive committee of the Council; **Daniel Harrington,** of the United States Bureau of Mines, has become secretary and news letter editor; **J. J. Forbes,** also of the Bureau, is chairman of the poster and slide committee; **J. W. Alt,** of Calumet & Hecla Consolidated, is chairman of the program committee; **M. R. Budd,** of *The Explosives Engineer,* is chairman of the publicity committee; and **W. W. Adams,** of the United States Bureau of Mines, is chairman of the statistics committee.

Frank Ayer, general manager of Roan Antelope Copper Mines, Ltd., recently announced the following changes in the Roan Antelope organization: **R. M. Peterson,** who has served that company since July, 1928, is promoted to the position of assistant general manager. **Wilfred J. MacKenzie** is advanced from the position of underground manager to that of mine superintendent. Mr. Peterson came to Roan Antelope as mine superintendent in July, 1928, and has been continuously in charge of that department from the beginning of active underground development work on through the period when the choice of equipment and method of mining were decided upon, to the present normal operating stage. The Roan Antelope mine, which was the first in the district to come into production, introduced the sublevel method of mining, and both Mr. Peterson and Mr. MacKenzie had a lot to do with modifying that method to suit Roan Antelope conditions. Mr. MacKenzie's former position of underground manager is being filled by **Alex W. McNeil,** assistant underground manager.

C. W. Van Law, of Carson City, Nev., has taken over the operation of a young gold mine which, he writes, seems to have considerable promise, in that it has paid for its entire development, equipment, and a 75-ton cyanide plant from eleven months' profits out of a less than $8 ore, and all above the 175-ft. level. From an insignificant showing on the zero level where first cut, the orebody has lengthened to 500 ft. on the 175, is ten sets wide in a considerable part of this length, and is mined with an auger instead of a drill. The vein as just crosscut 100 ft. below the old bottom level shows 22 ft. of $10 ore and 21 ft. additional of lower grade. The operators have had single days of $84.30 mill heads. As the property is largely virgin, and the length of the ore zone undetermined on strike, the possibility of considerable ore is apparent. If developments continue as at present indicated, the small present mill will give way to a much larger sometime next summer. The name of the new company is Hidden Lake Venture, Inc., with three New York friends of Mr. Van Law and himself as the principal stockholders.

A. I. Edwards, secretary of the Chicago Section of the A.I.M.E., directs attention to an inaccuracy in the Personal items in the October issue respecting the election of J. R. Van Pelt to the presidency of the Western Society of Engineers. Mr. Van Pelt's recent election to the presidency of the Society initiates his first term in that office, not, as stated, his third. The first mining man to be so honored was J. A. Garcia (1929–30); the second, C. E. Whittier (1934-35).

OBITUARY

P. H. Ross-Munro, Rand pioneer mining man died recently at the age of 66.

William Sollas, professor of geology at Oxford University for 39 years, died in Oxford on Oct. 22 at the age of 87.

Robert S. Craig, a native of Indiana, who had been active in Mexican mining for nearly half a century, died recently at his home in Balsas, Guerrero.

Dr. Samuel Montgomery Kintner, vice-president in charge of engineering of the Westinghouse Electric & Manufacturing Company, internationally known for his research work and pioneering in the development of radio communication and broadcasting, died in Pittsburgh, Pa., on Sept. 28, at the age of 66.

Isadore Aaron Ettlinger, mining geologist and consulting engineer, was found dead in his office at 149 Broadway, New York City, on Oct. 3. Mr. Ettlinger was formerly for a long period connected with the Magma Copper Company. He was 50 years old.

Colonel Henry May, a mining engineer who had practiced his profession in the Far West for many years, and

who retired about twenty years ago, died at his home in Southampton, Long Island, on Oct. 5, at the age of 83. He served in the Spanish-American War, attaining the rank of colonel.

Jeff Casserly, prospector, miner, and philosopher, who had spent most of his life in Nevada and Sierra counties, Nev., died at Nevada City on Sept. 21. Casserly contributed mining comment to the *Downie Messenger* under the pen name of "Bull Quartz," and years ago was "specimen boss" at 16 to I mine, at Alleghany, Calif.

William A. Parks, head of the department of geology at the University of Toronto for the past 26 years, died at Toronto on Oct. 3 at the age of 68. He was a graduate in geology and moderns from the University of Toronto in 1892 and was a former president of the Royal Society of Canada, of the Paleontological Society of America, and the Royal Canadian Institute.

Milton Kerr Campbell, general manager in Mexico of Minas del Tajo, S. A., at Rosario, Sinaloa, and other Bradbury mines, died on Sept. 26 of a heart attack. Mr. Campbell's death followed one of the worst tornados the country has experienced. Nearly all of the surface buildings were destroyed by the windstorm. The lower levels of the mine were flooded by the heavy rains and stoppage of the power plant followed. Rainfall this season has exceeded 72 in. After a ten-day shutdown the work of unwatering the mine and repairing damaged buildings has been resumed. **Frank Cooper,** an old employee of the company, has been named general manager, and it is hoped that the mine will again be in operation by Nov. 1.

A LETTER

Inferences to Be Drawn From Report of National Resources Committee Held Unduly Pessimistic

The Editor:

I have just finished a perusal of the Report on the Mineral Reserves of the United States issued by the National Resources Committee, on which your August issue carried a comment by your Washington correspondent. This is a valuable and timely document and should be studied by all who are interested in our mineral industries or other industries directly or indirectly dependent upon raw materials derived therefrom.

But with all due diffidence I cannot refrain from registering a protest against the pessimistic inferences which might logically be drawn from the conclusions of the Committee in its forecast of the comparatively early date of exhaustion of many of our domestic sources of metal supply and the improbability that the present picture will greatly change in the future.

I seem to recall that some thirty years ago certain eminent engineers predicted that copper would be selling at 50c. per pound by 1925 and suggested curbing the export of that metal to conserve our limited national supply; that was before Jackling and others showed us how to utilize the porphyry deposits, the full extent of which has by no means been measured. I also recall that less than twenty years ago we who were burning fuel oil in copper reverberatories were solemnly warned by high authority that lack of oil would force us all to switch over to powdered coal before the end of a decade; that was before the discoveries of new oil pools in West Texas and elsewhere caused such a surplus that legislative action and even armed force had to be used to curb the output. Who shall say that many similar fields do not still await discovery?

A report on our mineral resources written before 1900 might well have assumed that the United States would continue to import the bulk of its sulphur, but since then the application of the Frasch process has given us control of the world market. Our reserve of molybdenum would have been estimated as very problematical until the Climax orebody was developed during the last few years, and in that same period new discoveries of gold, silver, and copper mines have not been lacking.

Now, it is my humble opinion that the domestic supply of almost every useful mineral is dependent rather upon its relative value than upon the absolute limitations placed upon us by nature. We know that even in the case of chrome, manganese, nickel, and tin, of which there is almost no present domestic production, deposits exist which could be worked with profit if war or tariff should exclude the imports from countries which are more favored by nature in these respects. There are many mines of copper, lead, zinc, mercury, and silver which have been profitably operated during periods of high prices and will surely resume activity at any time that similar conditions return.

As to gold, and this is surely an item of paramount importance, I believe that nearly every engineer who has had extended field experience will agree with me when I say that it is a practical impossibility to even guess at the quantity which may conceivably be worked with profit if the price of that metal continues to advance.

Without venturing to express any opinions as to the merits of the case, it is my firm belief that the relative price of gold will continue to move upwards just as long as it remains the only recognized international standard of value. The debts which the nations of the world are piling up, the vast expenditures which they are making in excess of income, the feverish preparations for war, the ever-mounting burden of taxation, and the self-interest of the nations which produce or hold the world's gold supply all combine to increase the value of this metal in terms of every other commodity and most of all in terms of steadily depreciating national currencies and I fully expect to see gold valued at $40, $50, perhaps $60 per ounce before another twenty years have rolled by. Of course, this will also mean higher costs for labor and supplies, but the gold advances will come first and the gold producers will continue to reap the harvest while other prices are catching up.

Already the advance of $20 to $35 per ounce has made available large tonnages of ores which were non-commercial five years ago, and there are far vaster tonnages which will become the ore of tomorrow if my prediction proves to be correct. Coupled with the rising price of this metal have come great reductions in costs of mining and treatment, pioneered by the porphyry coppers and such mines as Alaska Juneau and pushed along by non-mining projects like the Boulder Dam and Grand Coulee, until mining operators now confidently talk of handling with profit placer or even hard-rock tonnages that carry values so low as to have formerly prohibited any type of mining except hydraulic or dredging and under the most favorable of conditions. There are still many million tons or cubic yards of such material to be mined, not only in the tertiary gravels of the Far Western states. There are gold-bearing lake beds and dry placers in the desert regions and there and elsewhere rock formations with gold in quartz veins or fracture seams which are so plentiful as to give the whole mass a tangible value. There are copper and lead mines which would quickly be put in operation, even though the markets for the base metals should remain as at present, if a substantially higher value were attached to the gold which is associated with them.

Finally, we have such enormous areas as the clays of the Chinle or Painted Desert formation, where surface assays seem to indicate the probability of gold content in the order of *eight cents* per cubic yard. Doubtless there are other similar formations which remain to be explored and whose mining and treatment problems await their solution at the hand of future generations of engineers.

I am not trying to boost for our mineral industries nor for any metal, mine, or district, least of all to suggest that present policies should be based on wishful visions. But it is my very earnest hope that this report on our mineral reserves or lack of known mineral reserves will serve not only as a warning but mainly as a stimulant both to the Government and private enterprise for seeking additional sources of these minerals and better and cheaper ways of mining the raw materials and converting them to useful products.

Canada, South Africa, and, most of all, Soviet Russia have made strenuous efforts along these lines with marked degrees of success, and, if we act on the principle that the limitation of most of our mineral resources is not primarily a question of existing tonnage but of relative price coupled with scientific progress, then I strongly contend that the rather gloomy picture painted by the National Resources Committee will soon be so far altered as to become entirely unrecognizable and that, given the demand, we in the United States will find and produce the supply for a far longer period than need concern any one of us now living or even our descendants "unto the third and fourth generation."

GEORGE M. COLVOCORESSES.
Phoenix, Ariz.

NEW BOOKS

A Field Handbook

FLOTATION PLANT PRACTICE. SECOND EDITION. *By Philip Rabone. Published by Mining Publications, Ltd., London, England. Pp. 165, with 72 illustrations and 38 tables. Price 10 s. 6d.*

This book is the second edition of a book first published in 1932. It does not differ materially from the first edition, with the exception that the section on the flotation of gold ores has been entirely rewritten and brought up to date. In addition, descriptions of a few new machines and some additional mill circuits of importance have been added to the text.

It contains seven chapters and two appendices, the titles suggesting the logical sequence of the operations performed in a flotation flowsheet: Introduction, Crushing, Grinding, Flotation Reagents, Flotation Machines, Flotation Methods, Concentrate and Tailing Disposal, and Capital Cost of Flotation Plant, and Launder Slopes—Pumping Water. As indicated in the two prefaces, the author has availed himself of information furnished by manufacturers of machinery commonly used in flotation mills.

As an introduction, definitions of terms used in the text and descriptions of the flotation process and of the flotation plant are given in the first chapter. Also, brief discussions on the ores amenable to flotation, and on the importance of size, are given in this chapter.

Under "Crushing" the author describes the layout of the crushing plant. Primary and intermediate crushers, conveyors, grizzlies, feeders and screens are adequately described and pertinent data relative to each of these machines are briefly tabulated. The chapter also contains brief discussions on the choice of the primary breaker, on the size of crushing plant, and on the running costs of crushing plants. It is interesting to note that the crushing rolls as a crusher are not mentioned in this chapter.

Under "Grinding" the author describes briefly the construction and operation of cylindrical ball mills, conical ball mills, rod mills, classifiers, pumps, and samplers, giving at the same time, in tabulated form, pertinent data relative to each machine. Brief discussions on grinding, on the critical mesh of grinding, on cylindrical versus conical mills, and on running costs of grinding are included. The chapter includes also descriptions of various types of grinding circuits, and the relative merits are briefly discussed.

Chapter IV is an attempt to present in non-technical language the present theories on the mechanisms of frothing, of collection, and of conditioning. This chapter, in the opinion of the reviewer, is for the most part a poor presentation of the experimental facts known today on these three phases of flotation phenomena. If this section is an abstract of the literature on the subject, it is an incomplete and inadequate one. If it is an exposition of the author's own views, it indicates that the author has not been following the work of research workers in this field carefully. Further, if the author believes that the knowledge of the action of flotation reagents is still in a chaotic state, his practice, in this book at least, to avoid references, makes the bulk of this theoretical presentation utterly worthless.

After classifying flotation reagents into frothing reagents, collecting reagents, promoting reagents, modifying reagents, depressing reagents, and activating reagents, the author discusses each class separately and mentions a few reagents of each class and their individual properties. This chapter includes also brief descriptions of reagent feeders and of conditioning tanks.

The construction and operation of the better-known flotation machines are described in Chapter V. Tabulated data pertaining to each of these machines are also given. This chapter includes further brief discussions on the choice of flotation machines and gives, in addition, methods to calculate the sizes of conditioning tanks and of flotation machines.

In the next chapter several types of flotation circuits are described and discussed. The chapter includes, also, digests of the current practice in treating copper ores, lead ores, zinc ores, lead-zinc ores, copper-lead ores, copper-zinc ores, and gold and silver ores. Finally, the chapter concludes with a discussion of the running costs of the flotation sections of flotation mills.

Construction and operation of thickeners and filters are described in Chapter VII. Pertinent data on these types of machines are tabulated. This chapter includes, also, a brief discussion of tailing disposal and of the running costs of filtering, of thickening, and of tailing disposal.

The author has made the book brief without sacrificing clarity. Therein lies its chief merit. Thus, the book, though not a comprehensive treatise on the subject, is really a reliable field-handbook, in which useful information may be rapidly found. Descriptions of practices and machines not commonly used, or relatively antiquated, have been left out of the text, and those of machines and of practices in vogue today are adequately treated. With the exception of the section on flotation reagents, the book is recommended as a welcome addition to the rapidly growing list of books on flotation.

GUIDO R. M. DEL GIUDICE

SPECTRUM ANALYSIS. *By Lester W. Strock, Ph.D., with a preface by Prof. V. M. Goldschmidt. Pp. 54. Illustrated, bound in limp cloth. Published by Adam Hilger, Ltd., 98 Kings Road, London, N.W. 1. Price 5s. 6d. net, 5s. 8d. post free.*

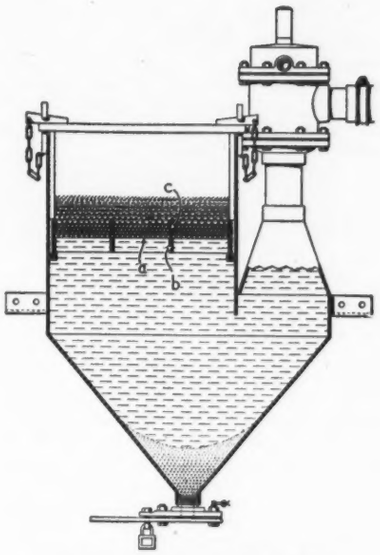
This book gives an account of the special methods of spectrum analysis applied to minerals by Prof. V. M. Goldschmidt and his co-workers at Göttingen. These methods made possible the systematic work, commenced at Oslo and continued until recently at the University of Göttingen, on the abundance and geochemical distribution of the chemical elements.

The author spent some two and a half years as a visiting investigator at the Göttingen laboratories, and thus is able to present a coherent summary of the work carried out. He gives an account, also, of developments in the technique which he himself introduced during this time. The book is illustrated with several photographs of the apparatus as well as line diagrams and curves. It should be of interest to all who are concerned with rapid analyses of such non-conducting powders as rocks, minerals, glasses, slags, ashes, clays, and soils.

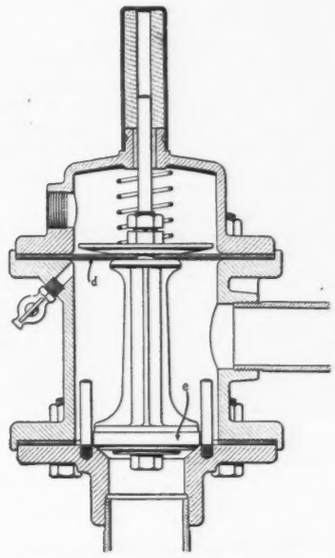
THE MINERAL INDUSTRY, 1935. *Edited by G. A. Roush, McGraw-Hill Book Company, New York. Pp. 754. Price $12.*

Volume 44 of this long-established annual, just off the press, maintains the high standards set by preceding numbers. The list of contributing authors inspires confidence in the contents and insures reliability of data. In addition to statistical data on production and consumption of metals and non-metals, the various chapters contain reviews of technology covering advances made during the preceding year. Economic discussions round out each topic in such a manner as to give the reader complete coverage of the mineral industries. Data are included on United States tariff rates on minerals and metals. The continued publication of *Mineral Industry* makes it invaluable for purposes of comparing current conditions with those of earlier years.

EQUIPMENT NEWS



a—screen supporting jig bedding
b—grid supporting screen
c—grid clamping down screen



d—flexible rubber diaphragm
e—valve

NEW PULSATING JIG FOR GOLD CONCENTRATION

Pan-American Engineering Corporation, Ltd., 820 Parker St., Berkeley, Calif., has developed a jig for gold concentration activated by a pulsator valve of an entirely new type. The unit is designed for use on stamp- or ball-mill discharge, or tailing from flotation, amalgamation, or cyanidation, as well as in gravel or placer operations. The principal feature of the new jig is the pulsator valve. This auxiliary controls the flow of water downward into one side of a steel hutch covered by a coarse screen reinforced on its upper and lower faces by grids. The screen supports a bed of shot holding the ore or gravel bed, which is kept "alive" by the flow of water through the pulsator valve.

The pulsator consists of a rubber valve and a flexible rubber diaphragm rigidly fastened one below the other to a common valve stem with a light alloy spacer between. When water under pressure is admitted to the pulsator between the valve and the diaphragm, the latter first bulges upward until the tension in the diaphragm is sufficient to lift the valve off its seat. This permits the water to escape around the valve and into the jig hutch. Escapement of water partly relieves the pressure on the diaphragm and as a consequence the valve snaps shut. This action is repeated at high frequency.

As the pulp builds up on the shot bed, the rapid pulsations of the water from the pulsator keep the entire mass gently agitated, with the result that the heavier particles such as gold, sulphides, and black sand work down through the pulp, shot bed, and screen and settle into the bottom of the hutch. The lighter gangue is carried over the bed and rejected as tailing. Concentrate in the hutch may be drawn off continuously or intermittently, and the outlet can be padlocked between intermittent bleedings.

The newly developed valve has been actuated with a pulp containing as much as 40 per cent solids, and the manufacturer claims it will give a far higher cycle frequency than has ever been practicable with any older type of valve. Normal operating speed is from 300 to 600 strokes per minute, and the intake head may vary from 10 to 75 ft. without affecting the efficiency of the pulsator, although 20 ft. is about the optimum head for most operating conditions. Because of the high pulsator frequency, the screen bed normally can be kept activated with only 10 to 12 gal. of water per square foot of screen area, and in exceptional cases 6 gal. has been found sufficient.

Capacity of the jig is from 200 to 250 tons of ore per day per square foot of screen area in ball mill-classifier circuits, and from 100 to 150 tons on tailings or placer gravel, with feed varying widely in dilution. In placer installations and on mill tailings the pulp can be as dilute as 10 to 15 per cent solids, and in ball mill-classifier circuits the jig feed can be as thick as 60 to 70 per cent solids. Machines have been designed for use in mills and for small placer operations, and for dredges where the unit must be placed directly in the sluices the company manufactures duplex "stream-flow" units.

Self-Locking Screw Threads

A self-locking screw thread which is said to remain tight under all service conditions without lock washers, jam nuts, cotter pins or other auxiliary locking devices is announced by the Dardelet Threadlock Corporation, of 120 Broadway, New York City. The manufacturer says that the thread can be formed in all workable materials by all commercial processes. To suit special conditions it can be made in alloy steels in non-corrosive metals and with the commonly used platings and rust-proof finishes.

The action of locking is said to be due to the elasticity of the metal, is entirely within the elastic limit, and therefore without permanent deformation of the threads. The manufacturer states the locking is caused by static friction set up by elastic pressure between the contact surfaces of the bolt and nut and that this elastic pressure is produced by continuing to turn the nut with the wrench after the nut is sealed against a resisting surface. Unlocking the nut is done by simply turning the wrench. Dardelet lock-threaded bolts and nuts are said to be successfully used instead of rivets on ore scrapers operated in connection with tugger hoists.

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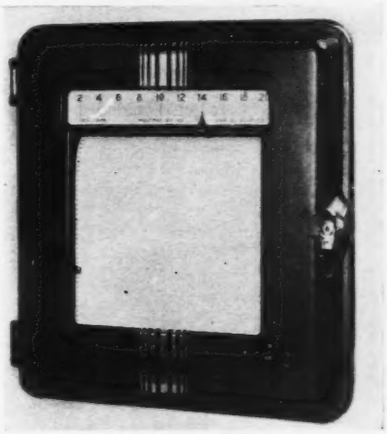
Recording Machine

The "Silver Anniversary" Micromax recorder was recently announced by Leeds & Northrup Company, 4934 Stenton Ave., Philadelphia, Pa.

Marking the 25th year since this concern originated the recording potentiometer pyrometer, this Micromax is said to provide in the one instrument all combinations of indicating, recording, signaling, and controling in ways unique to this model. Measurements are conveniently presented



by a scale and pointer showing the condition at the moment, and a clear record of ten visible inches of strip-chart shows it for the past several hours. On controllers, a second pointer shows control setting. Multi-point records may be in blue or in multi-color.

This Micromax is said to have control and signal contacts operating undisturbed by air currents when the door is opened

for a chart change or the pen refilled. The pen holds seven weeks' ink supply. A double frame makes all parts of the mechanism strikingly accessible, and enables the user to replace the chart without effect on other parts of the recorder.

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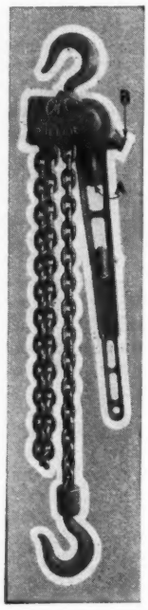
Puller



Chisholm-Moore Hoist Corporation, Tonawanda, N. Y., has recently introduced the "CM" Puller, a general-utility tool for lifting or pulling vertically, horizontally, or at any angle. Capacities are ¾ ton and 1½ ton. The device is intended for numerous pulling jobs, such as tightening guy wires, stretching fence, pulling posts, trench work, and also for general maintenance and construction service.

A gear reduction in both capacities provides for a minimum amount of effort to operate the ratchet handle—43 lb. to pull ¾ ton. Light weight greatly facilitates handling—¾-ton size weighs 17 lb. Little space is required in service or storage, as minimum distance between hooks on ¾-ton size is said to be only 9 in. Handle is collapsible for tool-box storage. "Herc-Alloy" double-duty, alloy-steel chain is provided with a strength said to be in excess of five times capacity load. Operation is controlled by two buttons, A and B, which are said to permit quick adjustment of chain.

Mechanism and automatic friction brake are fully inclosed, with no exposed bearings or springs, and are packed in grease, with no further lubrication required.

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Small Centrifugal Pump

The Worthington Pump & Machinery Corporation, Harrison, N. J., announces a small centrifugal pump, said to be of high quality and low cost. Simplicity of design is said to result in fewer wearing parts and low maintenance costs. The compactness of the unit makes it easily adaptable to almost any installation within its head capacity range. The pumps are furnished with direct motor drives or with pulleys for belt drive. Motor sizes range from one-third to three horsepower, delivering from 10 to 130 gal. per minute with heads from 10 to 100 ft.

The shaft is supported by two ball bearing inclosed in a dirtproof and moisture-proof housing. The suction head is easily removable for inspection of the pump's interior. A choice of standard, all-iron, and all-bronze fittings is offered.

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Flue-Gas Analyzer

The Hays Corporation, P. O. Box 299, Michigan City, Ind., announces a portable flue-gas analyzer of new design known as the Orsotomot. It is said a sample of flue gas can be analyzed in 20 seconds by simply operating a lever, and the results are plainly indicated by a pointer movement on a large legible scale. The device consists of a rotable analyzing body which contains the measuring and absorption chambers and is charged with mercury and an absorbing chemical, the metallic bellows and linkage for moving the pointer; an aspirator bulb and the necessary rubber tubing, and a pressed-steel case of special non-tipping design fitted with a convenient carrying handle.

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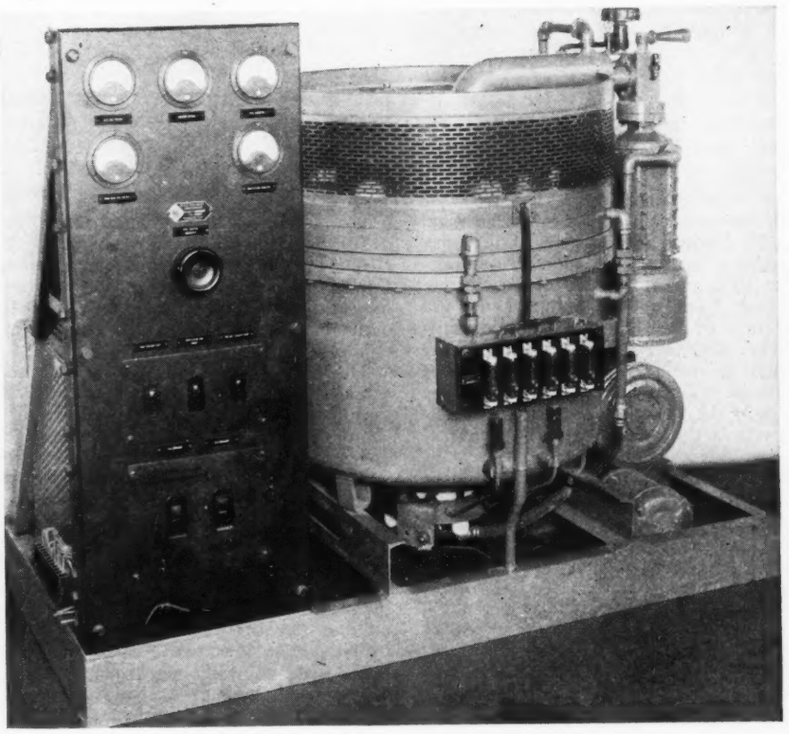
Battery Discharge Indicator

A new indicator instrument is announced by the Electric Storage Battery Company, 19th St. and Allegheny Ave., Philadelphia.

The indicator is a small device, measuring 4¾ x 5$\frac{11}{16}$ x 3⅝ in., and is mounted on the truck in sight of the operator. When the voltage drops to a predetermined point, a red bullseye flashes its warning signal to the operator, who then knows that the battery should be replaced at once with one fully charged. The operation is simple. A relay is set to operate on a predetermined voltage (25 volts for a 15-cell battery). When the battery discharges to the pre-

ALIMINUM WHEELBARROW developed by the Sheet Aluminum Corporation, Jackson, Mich., which is said to permit a saving of 40 lb. in dead load, thereby permitting an increase of 15 per cent in the pay load. The addition of pneumatic tires is said to produce a perfect balance and eliminates shock



LOW-VOLTAGE RECTIFIERS

The Allis-Chalmers Manufacturing Company, Milwaukee, Wis., announces the development of a low-capacity, simplified, all factory-assembled, grid-controlled mercury arc rectifier set with a rating of 150 kw. at 250 volts and 300 kw. at 550 volts, direct current. This set is said to have the rectifier tank, all auxiliaries, and control panel assembled and wired on a common frame. The set occupies a floor space of only 3½x6 ft., stands about 5 ft. high, and weighs approximately 3,500 lb. Due to simplicity of installation and operation, small space requirements and high conversion efficiency, particularly at partial loads, this rectifier is said to be well adapted for power conversion in unattended substations or in places where a change-over from d.c. to a.c. network is taking place. This rectifier will also find an application in many industrial plants where a small amount of d.c. power is required for special drives or processes. It is said to find application in d.c. power supply to mine haulage systems.

determined point, the relay trips and current flows to the signal lamp, light from which can be seen for quite a distance. The device is made in standard sizes for operation with 12-cell, 15-cell, 16-cell, and 18-cell batteries. The company will supply special indicators to operate with other combinations of cells.

THE P-H ELECTRIC EXCAVATOR manufactured by the Harnischfeger Corporation of Milwaukee, Wis., is said to offer greater speed in the digging cycle through greater electrical horsepower per yard of dipper

BULLETINS

Furnace Boilers. Babcock & Wilcox Co., 85 Liberty St., New York, N. Y. Bulletin G-17-A, describes and illustrates the coordinated steam-boiler units using either pulverized coal, oil, or gas. Pp. 24.

Welding. Linde Air Products Co., 30 East 42d St., New York, N. Y. Pamphlet on technique of fusion welding brass and bronze and commercial yellow brass pipe. Pp. 12.

Compressors. Sullivan Machinery Co. Dept. 21, Michigan City, Ind. Bulletin 88-0, describes the "Unitair" two-stage, air-cooled, single-acting stationary compressor in four sizes up to 400 c.f.m.

Single-Roll Crusher. Jeffrey Manufacturing Co., Columbus, Ohio, Catalog No. 621, illustrating crushers for non-metallics. Tables and illustrations, diagrams. Pp. 19.

Aftercoolers. Ingersoll-Rand Co., Phillipsburg, N. J. Bulletin No. 2239, describing a new design of aftercooler serving air and gas compressors of moderate capacities. Pp. 3.

Boltless-Lined Ball Mill. American Ball Mill Co., Patterson Building, Denver, Colo. Bulletin J-2, describing and illustrating the new positive-discharge ball mill. Pp. 11.

Inclosed Fan-Cooled Motors. Reliance Electric & Engineering Co., Ivanhoe Road, Cleveland, Ohio. Bulletin 214, describing the advantages of heavy-duty motors protected against dirt, dust, or fumes. Pp. 4.

Refractory Mortars and Plastics. Babcock & Wilcox Co., 85 Liberty St., New York, N. Y. Illustrated pamphlet containing mortar and plastic reference table. Pp. 6.

Clark-Todd Amalgamator. Mine & Smelter Supply Co., Denver, Colo. Description of an apparatus embodying new applications of gravity and amalgamation to the recovery of free gold. Pp. 8.

Scrapers. Holcomb-Westeeco design made by Twin City Iron Works, Hurley, Wis., and Western Alloyed Steel Casting Co., Minneapolis, Minn. Catalog No. 2, describing scrapers for use with tuggers of 7 to 50 hp. Pp. 29.

Packing. Crane Packing Co., 1800 Cuyler Ave., Chicago, Ill. Folder describing anti-friction plaster packing. Pp. 4.

Self-Locking Screw Thread. Dardelet Threadlock Corp., 120 Broadway, New York, N. Y. Bulletin No. 5 describing the principle of self-locking nuts and bolts and screws. Pp. 30.

Float-Operated Valves and Switches. McDonell & Miller, Wrigley Building, Chicago, Ill. Illustrated catalog of boiler-water level controls. Pp. 32.

INDUSTRIAL NOTES

This year the firm of Abbot A. Hanks, Inc., of Sacramento St., San Francisco, celebrates its seventieth anniversary. In 1866 Henry G. Hanks established a laboratory for general assay and chemical work, and the name and business have been carried on continuously since that time in San Francisco with the exception of eleven months following the earthquake and fire of 1906, when offices were temporarily located in Oakland.

Coming to California in 1852, Henry G. Hanks engaged in several lines of work, one of which was the building of the first borax refineries in California. Interested in minerals and metals, he established one of the earliest custom assay offices and chemical laboratories in the State. His son, Abbot A., joined him about 1887, and on the retirement of the elder Hanks the business was transferred to him in 1896. In 1917 a larger force was employed and the scope of the work was widened. In 1924 the firm was incorporated and a number of the older employees were given an interest in the corporation. The firm's activities have broadened, and today it has laboratories and equipment for the assay and analyses of ores, minerals, metals and metal products, for general inorganic analysis, for the testing of cement, aggregates, steel, and building materials. It specializes in the sampling of ores, mineral products at smelter, warehouse, or ship side.

Beginning in a small way with the personal work of the founder and a boy helper, the firm now employs a regular force of 25, most of them technically trained, and this is supplemented by representatives at smelters, cement plants, and steel mills all over the Pacific Coast. Through its affiliates in Eastern and Southern cities, a general inspection service is afforded throughout the United States.

Harry C. Hicks has been appointed sales manager of the Chicago district by the New York Belting & Packing Company, with headquarters at 3550 South Morgan St., Chicago, Ill.

Cutler-Hammer, Inc., manufacturers of electric control apparatus, Milwaukee, Wis., announce the operation of new plant at 970 Folsom St., San Francisco.

New York Belting & Packing Company announces that it has appointed Laib Company, Inc., 754 South First St., Louisville, Ky., as distributor of N.Y.B.&P. products in the Louisville territory.

E. D. Bullard Company, of Los Angeles, has been appointed Western distributor of the Wheat portable electric safety lamps made by the Koehler Manufacturing Company, of Marlboro, Mass.

A New England Office, staffed for consulting and sales engineering service on the company's recording and controlling instruments, has been opened in Boston by Leeds & Northrup Company. The address is, 422 Chamber of Commerce Building, 80 Federal St., Boston.

Twelfth National Exposition of power and mechanical engineering will be held at Grand Central Palace, New York, from Nov. 30 to Dec. 5, 1936. Dynamic and interesting displays designed to give the visitor the maximum information in the shortest possible time will present every new development in the field of power generation and mechanical engineering equipment.

Babcock & Wilcox Tube Company, Beaver Falls, Pa., announces changes in its representation in its Southwestern sales territory, including the appointment of H. S. Dershimer as Tulsa, Okla., district sales manager, with offices in the Philtower Building, and direct representation in Houston and Dallas, Texas.

SUMMARY OF

MONTHLY COMMENT . . . DAILY AND AVERAGE MONTHLY

COPPER and lead prices advanced in the domestic market during the last month on continued favorable news on the state of business and widespread optimism over the outlook. The election campaign had comparatively little influence on the trade. London prices moved into higher ground on a combination of circumstances, including greater industrial activity, rearmament, favorable statistics, and increased speculative operations for a sustained rise in prices because of currency depreciation and steady pressure to deliberately cheapen money. Sterling exchange for October averaged $4.98755, against $5.03455 in the preceding month.

Our index number of non-ferrous metal prices for October was 73.22, a new high for the year. In September the index stood at 73.01.

Spurred by higher prices in London, accounted for partly by a squeeze on the Metal Exchange, domestic consumers of copper became nervous and bought in a larger way. In the last week of the month the sales assumed the proportions of a buying wave and transactions for October finally amounted to 178,801 tons, the largest total for a single month on record. On Oct. 28 the price definitely moved to the 10c. Connecticut basis, the highest price since Jan. 28, 1931. Production of copper is being increased rapidly. Domestic mine output for September was 58,290 tons, against 43,200 tons in August, and production for October is expected to be substantially larger than in the month previous. In fact, some authorities on copper believe that total domestic production—mine and scrap—already is in excess of the "actual" needs of consumers.

Demand for lead was active and the price advanced 20 points, to 4.80c., New York, a new high since January, 1931.

Negotiations are in progress for a miners' zinc cartel centering on foreign production and marketing of concentrate.

Domestic stocks of copper, lead, and zinc on Oct. 1, compared with holdings at the beginning of the year, in short tons, were as follows:

	Jan. 1	Oct. 1
Refined copper	231,415	188,517
Refined lead	222,306	200,517
Zinc (all grades)	83,936	76,630

United States Market

1936 Oct.	Electrolytic Copper—Domestic (a)	Electrolytic Copper—Export (b)	Straits Tin New York	Lead—New York	Lead—St. Louis	Zinc St. Louis
1	9.525	9.450	45.626	4.60	4.45	4.85
2	9.525	9.450	45.475	4.60	4.45	4.85
3	9.525	9.450	45.400	4.60	4.45	4.85
5	9.525	9.450	45.675	4.60	4.45	4.85
6	9.525	9.450	45.250	4.60	4.45	4.85
7	9.525	9.425	45.000	4.60	4.45	4.85
8	9.525	9.450	45.150	4.60	4.45	4.85
9	9.525	9.475	45.300	4.60	4.45	4.85
10	9.525	9.500	45.250	4.60	4.45	4.85
12	Holiday	9.550	Holiday	Holiday	Holiday	Holiday
13	9.525	9.600	44.500	4.60	4.45	4.85
14	9.525	9.650	44.750	4.60	4.45	4.85
15	9.525	9.675	44.450	4.60	4.45	4.85
16	9.525	9.700	44.450	4.60	4.45@4.50	4.85
17	9.525	9.700	44.375	4.60	4.45@4.50	4.85
19	9.525	9.700	45.000	4.60	4.45@4.50	4.85
20	9.525	9.700	44.550	4.60	4.45@4.50	4.85
21	9.525	9.725	44.125	4.60	4.45@4.50	4.85
22	9.525	9.800	43.950	4.60	4.45@4.50	4.85
23	9.525	9.825	44.200	4.60	4.45	4.85
24	9.525	9.850	44.200	4.60	4.45	4.85
26	9.525	9.850	44.000	4.60	4.45@4.50	4.85
27	9.525	9.825	44.625	4.70	4.55	4.85
28	9.775	9.875	45.625	4.70	4.55	4.85
29	9.775	9.900	46.375	4.80	4.65	4.85
30	9.775	9.975	46.125	4.80	4.65	4.85
31	9.775	10.050	45.925	4.80	4.65	4.85
Av. for month	9.563	9.669	44.975	4.631	4.488	4.85
Averages for Week						
Oct.						
7	9.525	9.446	45.404	4.600	4.450	4.85
14	9.525	9.538	44.990	4.600	4.450	4.85
21	9.525	9.700	44.492	4.600	4.471	4.85
28	9.567	9.838	44.433	4.633	4.492	4.85
Calendar Week Averages						
Oct.						
3	9.525	9.483	45.525	4.600	4.450	4.85
10	9.525	9.458	45.271	4.600	4.450	4.85
17	9.525	9.646	44.505	4.600	4.460	4.85
24	9.525	9.767	44.338	4.600	4.467	4.85
31	9.692	9.913	45.446	4.733	4.588	4.85

Silver, Gold, and Sterling Exchange New York and London

1936 Oct.	Sterling Exchange "Checks"	Sterling Exchange "90-day demand"	Silver (c) New York	Silver London	Gold London	Gold (d) United States
1	4.93500	4.92375	44.750	19.9375	140s 5½d	35.00
2	4.93000	4.92000	44.750	19.9375	141s 0 d	35.00
3	4.93125	4.91875	(e)	20.0625	141s 0 d	35.00
5	4.92000	4.90750	44.750	20.0625	141s ½d	35.00
6	4.90375	4.89375	44.750	20.1250	141s 7 d	35.00
7	4.88875	4.87750	44.750	20.1250	142s 0 d	35.00
8	4.89250	4.88250	44.750	20.1250	142s 3 d	35.00
9	4.90375	4.89375	44.750	20.0000	141s 10d	35.00
10	4.90500	4.89625	(e)	20.0000	141s 10½d	35.00
12	Holiday	Holiday	Holiday	20.0000	141s 11d	35.00
13	4.90000	4.89125	44.750	20.0000	141s 11d	35.00
14	4.89250	4.88500	44.750	20.0000	142s 0 d	35.00
15	4.89500	4.88750	44.750	20.0000	142s 1 d	35.00
16	4.89250	4.88500	44.750	19.9375	142s 1 d	35.00
17	4.88875	4.88125	(e)	19.8125	142s 2½d	35.00
19	4.88375	4.87625	44.750	19.7500	142s 4½d	35.00
20	4.89000	4.88250	44.750	19.6875	142s 3½d	35.00
21	4.89000	4.88125	44.750	19.8125	142s 1½d	35.00
22	4.89000	4.88000	44.750	19.8750	142s 1 d	35.00
23	4.88750	4.87750	44.750	19.9375	142s 2½d	35.00
24	4.88750	4.87875	(e)	19.9375	142s 2½d	35.00
26	4.88750	4.87875	44.750	19.9375	142s 3 d	35.00
27	4.88750	4.87750	44.750	19.9375	142s 3 d	35.00
28	4.89125	4.88125	44.750	20.1250	142s 2 d	35.00
29	4.88750	4.87750	44.750	20.1875	142s 1½d	35.00
30	4.88750	4.87750	44.750	20.0625	142s 2½d	35.00
31	4.88750	4.87750	(e)	20.0000	142s 3 d	35.00
Av. for month	4.89755	.....	44.750	19.977	.....	35.00
Averages for Week						
Oct.						
7	4.91813	.....	44.750	.....	.....	.....
14	4.89875	.....	44.750	.....	.....	.....
21	4.89000	.....	44.750	.....	.....	.....
28	4.88854	.....	44.750	.....	.....	.....

Calendar week averages: New York Silver, Oct. 3rd, 44.750; 10th 44.750; 17th, 44.750; 24th, 44.750; 31st, 44.750.

(e) No quotation (Saturday).

The above quotations for major non-ferrous metals are our appraisal of the important United States markets, based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

(a) Net prices at refineries on Atlantic seaboard. To arrive at the delivered New England basis, add 0.225c. per pound, the average differential for freight and interest charges.

(b) Export prices are net at refineries on the Atlantic seaboard and include sales of domestic copper in the foreign market. Most sales in the foreign market are made on the basis of c.i.f. usual ports of destination—Hamburg, Havre, and Liverpool. The c.i.f. basis commands a premium of 0.300c. per pound above our refinery quotation.

Copper, lead and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

Quotations for copper are for the ordinary forms of wirebars and ingot bars; cathodes are sold at a discount of 0.125c.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York commands a premium over the St. Louis basis equal to the freight differential. Contract prices for High Grade zinc delivered in the East and Middle West in nearly all instances command a premium of 1c. per pound over the current market for Prime Western but not less then 1c. over the *E. & M. J.* average for Prime Western for the previous month.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

(c) Silver other than newly mined domestic. Under Executive order issued April 24, 1935, the U. S. Government's price on newly mined domestic silver was established at 77.57. Handy & Harman's quotation for domestic silver, .999 fine, was 77c. per ounce throughout October.

(d) U. S. Treasury's gold price. Actual payment by the United States Treasury for gold in imported ore or concentrate is at 99.75 per cent of the price quoted by the Treasury, which at present is equal to $34.9125 per ounce.

THE MARKETS

PRICES OF METALS . . . MISCELLANEOUS QUOTATIONS

London Market

1936	Copper			Tin		Lead		Zinc	
	Standard		Electrolytic	Standard					
Oct.	Spot	3M	Bid	Spot	3M	Spot	3M	Spot	3M
1	39.6875	39.7500	43.7500	202.2500	199.0000	18.1875	18.1250	13.8750	14.1875
2	39.5000	39.6250	44.0000	201.5000	198.2500	18.5000	18.4375	14.0625	14.3125
5	39.7500	39.8125	44.0000	202.7500	199.7500	18.3125	18.2500	13.9375	14.2500
6	39.7500	39.8750	44.3750	202.5000	199.2500	18.1875	18.1250	13.8125	14.1250
7	39.7500	39.8125	44.2500	202.0000	198.7500	18.0625	18.0000	13.8750	14.1250
8	39.6875	39.8125	44.3750	202.5000	199.2500	18.1250	18.0000	13.8750	14.1875
9	39.8750	40.0000	44.5000	202.7500	199.5000	18.3125	18.2500	13.8750	14.1875
12	40.2500	40.3750	44.7500	201.0000	198.2500	18.2500	18.2500	13.9375	14.2500
13	40.5625	40.6875	45.0000	197.5000	196.0000	18.1250	18.0625	14.0000	14.3125
14	40.9375	40.9375	45.2500	200.0000	198.2500	18.2500	18.1875	14.1875	14.5000
15	41.0625	41.1250	45.2500	199.7500	197.2500	18.2500	18.1875	14.3750	14.6875
16	41.0000	41.1250	45.2500	198.0000	196.0000	18.4375	18.3750	14.6875	15.0000
19	41.3750	41.5625	45.5000	202.5000	200.2500	18.6250	18.5625	15.0625	15.3750
20	41.4375	41.6875	45.7500	199.5000	198.0000	18.6250	18.5625	15.0000	15.2500
21	41.8750	42.1875	46.0000	200.5000	198.7500	18.5625	18.5625	15.1875	15.4375
22	41.9375	42.2500	46.0000	196.0000	194.5000	18.5000	18.4375	15.1875	15.4375
23	42.3125	42.5625	46.2500	197.2500	195.7500	18.3750	18.3125	14.9375	15.1875
26	41.8125	42.1250	46.2500	198.2500	196.5000	18.5625	18.5000	15.3125	15.5625
27	41.5625	41.8750	46.0000	198.5000	197.0000	18.4375	18.3750	15.1250	15.3750
28	42.4375	42.7500	46.5000	205.5000	204.2500	18.6875	18.6250	15.0625	15.3125
29	42.3125	42.5625	46.5000	206.2500	204.7500	18.9375	18.8125	15.1875	15.4375
30	42.6875	43.0000	47.0000	209.5000	207.7500	19.5000	19.2500	15.6250	15.8750
Av. for month	40.980	.....	45.295	201.193	.....	18.446	18.375	14.554	14.835

Current Prices—Miscellaneous Metals, Ores, and Non-Metallic Minerals

Quotations cover wholesale lots, prompt shipment, f.o.b. New York, unless otherwise stated

(November 2, 1936)

Miscellaneous Metals

Aluminum, ingot, 99 plus per cent, lb.	19@21c.
Antimony, domestic, spot, lb.	11.750c.
Bismuth, ton lots, lb.	$1.00
Cadmium, lb.	75c@$1.05
Chromium, 97 per cent grade, lb.	85c.
Nickel, electrolytic cathodes, lb.	35c.
Magnesium, 99.8 per cent, carloads, lb.	30c.
Palladium, troy oz.	$24.00
Platinum, (official quotation) troy oz.	$48.00
Quicksilver, flask of 76 lb., 100 flasks or more	$88.50@$92.00
Radium, mg. radium content.	$40.00
Selenium, 99.5 per cent, lb.	$2.00
Silicon, minimum 97 per cent, spot, lb.	16.50c.
Tellurium, lb.	$1.75@$2.00
Thallium, 100 lb. or more, lb.	$6.50
Titanium, 96 to 98 per cent, lb.	$6.00
Zirconium, commercially pure, lb.	$7.00

Metallic Ores

Beryllium Ore, f.o.b. mines, ton	$30.00@$35.00
Chrome Ore, 45@47 per cent, c.i.f., long ton	$16.50@$16.75
Iron Ore, Lake Superior, long ton:	
Old Range bessemer	$4.80
Mesabi bessemer	$4.65
Old Range non-bessemer	$4.65
Mesabi, non-bessemer	$4.50
Lead (Galena) 80 per cent Joplin, Mo., ton	$52.50
Manganese Ore, c.i.f. Atlantic ports, long ton unit:	
52@55 per cent	27c.
49@51 per cent	26c.
44@47 per cent	25c.
Molybdenum Ore, 90 per cent, per lb. of contained MoS_2	42c.
Tungsten Ore, per unit of WO_3:	
Chinese duty paid	$15.00
Domestic Scheelite	$15.75
Vanadium Ore, per lb. of contained V_2O_5	27½c.
Zinc Ore, Prime, 60 per cent concentrate, Joplin, Mo.; per ton.	$31.50

Metallic Compounds

Arsenious Oxide (arsenic) lb	3½c.
Cobalt Oxide, 70@71 per cent, lb	$1.41@$1.51
Copper Sulphate, 100 lb	$4.00
Sodium Nitrate, ex vessel, in 200-lb. bags, per 100 lb	$1.34
Sodium Sulphate, bulk, ton	$13.00@$15.00

Alloys

Beryllium-Copper, Master alloy, 2.5 to 3 per cent Be, per lb. of contained Be	$30.00
Ferrochrome, 65@70 per cent chromium, 4@6 per cent carbon, lb	10c.
Ferromanganese, 78@82 per cent, gross ton	$75.00
Ferromolybdenum, 50@60 per cent Mo, lb. of Mo contained.	95c
Ferrosilicon, 50 per cent, gross ton	$69.50
Ferrotungsten, 75@80 per cent, lb. of W contained	$1.30@$1.40

Non-Metallic Minerals

Asbestos, f.o.b. mines ton:	
Canadian (Quebec)	
Crude No. 1	$550@.....
Crude No. 2	$200@$225
Spinning fibers	$90@$150
Paper stock	$32.50@$37.50
Shorts	$11@$14.50
Vermont	
Shingle stock	$47.50.....
Paper stock	$35@.....
Cement stock	$23@.....
Barytes, long ton:	
Georgia, crude	$7.00
Missouri, 95 per cent $BaSO_4$, less than 1 per cent iron	$5.50
Bauxite, long ton:	
Domestic, chemical, 55@58 per cent	$6@ $7.50
Domestic, abrasive, 78@84 per cent	$12.50@$15.00
Dalmatian, 50@55 per cent	(a)$5.50@ $7.00
French, 56@59 per cent	(a)$6.50@ 7.50
China Clay, f.o.b. mines, ton:	
South Carolina and Georgia, bulk	$7.00@ $9.00
Delaware, No. 1	$14.00@.....
Feldspar, bulk, ton:	
Potash feldspar, 200 mesh	$17.00
Glass-spar, white, 20 mesh	$11.75
Fluorspar, f.o.b. mines, bulk, Kentucky and Illinois 85-5 per cent, all rail movement, ton	$18.00
Fuller's earth, f.o.b. Georgia or Florida, ton	$7.00@$14.00
Magnesite, per ton:	
Dead-burned, f.o.b. California	$25.00@.....
Dead-burned, f.o.b. Washington	$22.00@.....
Mica, per lb., North Carolina, No. 1 and 2 quality:	
1½ x 2 in.	15@30c.
2 x 2 in.	30@50c.
3 x 3 in.	75@$1.00
3 x 4 in.	$1.00@$1.25
4 x 6 in.	$2.00@$2.50
White, ground, 70 mesh, ton	$60.00@$80.00
Ocher, Georgia, ton	$19.00@$22.50
Pyrites, Spanish, per long ton unit of S, c.i.f. Atlantic ports	(a)12@12½c.
Silica, water-floated, in bags, 325 mesh, ton	$16.00@$40.00
Sulphur, Texas mines, long ton	$18.00@.....
Talc, f.o.b. works, ton:	
New York, double air-floated, 325 mesh	$12.00@$15.00
New Jersey, mineral pulp	$8.00@$10.00
Vermont, extra white, 200 mesh	$8.50@ $9.00
Tripoli, Missouri, ton:	
40 mesh, cream colored	$15.00@.....
200 mesh, cream colored	$25.00@.....

(a) Nominal.

Iron and Steel

Pig Iron, Valley furnaces, gross ton:	
Bessemer	$20.00
Basic	$19.00
No. 2 Foundry	$19.50
Steel, base prices, Pittsburgh:	
Billets, gross ton	$32.00
Structural shapes, 100 lb	$1.90
Bars, 100 lb	$2.05

MONTHLY AND YEARLY AVERAGE PRICES

Silver and Sterling Exchange

	New York		London Spot		Sterling Exchange	
	1935	1936	1935	1936	1935	1936
January	54.418	47.250	24.584	20.250	489.207	496.115
February	54.602	44.750	24.818	19.796	487.278	499.908
March	59.048	44.750	27.380	19.663	477.635	496.952
April	67.788	44.892	30.986	20.245	483.596	494.139
May	74.356	44.869	33.865	20.248	488.587	496.850
June	71.940	44.750	32.346	19.770	493.245	501.817
July	68.216	44.750	30.500	19.590	495.558	502.178
August	66.366	44.750	29.476	19.490	496.815	502.519
September	65.375	44.750	29.255	19.579	492.917	503.455
October	65.375	44.750	29.368	19.977	490.577	489.755
November	65.375	.....	29.284	.....	492.277	.....
December	58.420	.....	25.563	.....	492.715	.....
Year	64.273	.....	28.952	.....	490.034	.....

New York quotations for silver not eligible for sale to U. S. Government, cents per ounce troy, 999 fine. London, pence per ounce sterling silver 925 fine. Sterling exchange in cents.

Copper

	F.O.B. Refinery, Electrolytic				London Spot			
	Domestic		Export		Standard		Electrolytic (a)	
	1935	1936	1935	1936	1935	1936	1935	1936
January	8.775	9.025	6.583	8.358	28.077	34.706	31.261	38.788
February	8.775	9.025	6.341	8.566	27.175	35.313	30.244	39.463
March	8.775	9.025	6.526	8.708	28.518	36.040	31.607	40.227
April	8.775	9.169	7.328	8.849	31.231	36.975	34.763	41.131
May	8.775	9.275	7.794	8.819	33.344	36.690	36.733	40.839
June	8.634	9.275	7.307	8.790	30.799	36.324	34.039	40.357
July	7.775	9.352	7.350	8.993	31.024	37.217	34.261	41.228
August	7.979	9.525	7.738	9.297	32.646	38.259	35.976	42.375
September	8.504	9.525	8.146	9.523	34.036	38.915	37.952	43.267
October	8.967	9.563	8.514	9.669	35.226	40.980	39.609	45.295
November	9.025	.....	8.414	.....	35.229	.....	39.396	.....
December	9.025	.....	8.414	.....	35.097	.....	39.313	.....
Year	8.649	.....	7.538	.....	31.867	.....	35.430	.....

New York quotations, cents per pound. London, pounds sterling per long ton
(a) Bid quotation.

Lead

	New York		St. Louis		London			
	1935	1936	1935	1936	1935 Spot	1935 3 Mos.	1936 Spot	1936 3 Mos
January	3.692	4.500	3.542	4.350	10.321	10.514	15.397	15.494
February	3.528	4.515	3.378	4.365	10.216	10.413	16.022	16.141
March	3.579	4.600	3.429	4.450	11.012	11.188	16.608	16.767
April	3.692	4.600	3.542	4.450	12.231	12.459	16.097	16.234
May	3.962	4.600	3.812	4.450	13.861	13.940	15.530	15.601
June	4.020	4.600	3.870	4.450	13.776	13.806	15.170	15.259
July	4.123	4.600	3.973	4.450	14.451	14.511	15.856	15.954
August	4.254	4.600	4.104	4.450	15.774	15.792	16.772	16.859
September	4.413	4.600	4.263	4.450	16.262	16.315	18.009	17.974
October	4.512	4.631	4.362	4.488	18.209	18.209	18.446	18.375
November	4.500	.....	4.350	.....	17.938	17.935	.....	.....
December	4.500	.....	4.350	.....	16.803	16.828	.....	.....
Year	4.065	.....	3.915	.....	14.238	14.326	.....	.....

New York and St. Louis quotations, cents per pound. London pounds sterling per long ton.

Tin

	Straits, New York		Standard, Spot, London	
	1935	1936	1935	1936
January	50.916	47.234	231.193	209.731
February	50.063	47.962	227.381	207.081
March	46.962	48.037	215.726	213.080
April	50.154	46.963	223.513	209.313
May	51.138	46.352	227.602	202.429
June	51.108	42.204	227.586	183.167
July	52.297	43.021	232.397	185.957
August	50.463	42.579	222.935	183.731
September	49.126	44.754	223.929	194.676
October	51.160	44.975	226.891	201.193
November	51.864	.....	226.452	.....
December	49.794	.....	220.075	.....
Year	50.420	.....	225.473	.....

New York quotations, cents per pound. London, pounds sterling per long ton.

Zinc

	St. Louis		London			
	1935	1936	1935 Spot	1935 3 Mos.	1936 Spot	1936 3 Mos
January	3.730	4.848	11.994	12.207	14.488	14.719
February	3.714	4.859	11.819	12.000	15.125	15.391
March	3.894	4.900	12.095	12.250	15.983	16.190
April	4.030	4.900	12.891	13.128	15.181	15.334
May	4.220	4.900	14.534	14.685	14.536	14.777
June	4.299	4.880	13.734	13.898	13.896	14.122
July	4.325	4.783	14.065	14.185	13.579	13.826
August	4.535	4.800	14.714	14.938	13.528	13.759
September	4.669	4.850	15.414	15.616	13.906	14.159
October	4.825	4.850	16.440	16.674	14.554	14.835
November	4.850	.....	16.193	16.372	.....	.....
December	4.850	.....	15.091	15.278	.....	.....
Year	4.328	.....	14.082	14.269	.....	.....

St. Louis quotations, cents per pound. London, pounds sterling per long ton.

Cadmium and Aluminum

	Cadmium		Aluminum	
	1935	1936	1935	1936
January	55.000	105.000	20.000	20.000
February	55.000	105.000	20.000	20.000
March	58.462	105.000	20.000	20.000
April	65.000	105.000	20.000	20.000
May	65.000	105.000	20.000	20.000
June	65.000	105.000	20.000	20.000
July	65.000	93.462	20.000	20.000
August	70.000	90.000	20.000	20.000
September	75.625	90.000	20.000	20.000
October	85.000	90.000	20.000	20.000
November	85.000	.....	20.000	.....
December	101.800	.....	20.000	.....
Year	70.491	.....	20.000	.....

Aluminum in cents per pound, 99 per cent grade. Cadmium, cents per pound.

Antimony, Quicksilver, and Platinum

	Antimony (a) New York		Quicksilver (b) New York		Platinum (c) New York	
	1935	1936	1935	1936	1935	1936
January	14.111	12.736	72.760	76.769	34.000	36.885
February	14.250	12.967	72.500	77.000	34.000	35.000
March	14.250	13.072	72.500	77.000	32.846	34.115
April	14.029	12.673	72.500	76.731	32.000	32.846
May	12.712	12.410	72.135	74.940	32.000	32.000
June	12.500	11.707	71.460	74.192	32.000	36.346
July	12.500	11.245	70.538	73.423	32.000	39.308
August	12.500	11.125	69.000	73.923	31.333	49.577
September	13.177	11.740	69.208	85.280	36.000	68.960
October	15.322	12.058	71.750	89.240	37.615	54.074
November	14.217	.....	74.348	.....	38.000	.....
December	13.820	.....	75.200	.....	38.000	.....
Year	13.616	.....	71.992	.....	34.150	.....

(a) Antimony quotations in cents per pound, for ordinary brands. (b) Quicksilver in dollars per flask of 76 lb. (c) Platinum in dollars per ounce troy.

Pig Iron

	Bessemer		Basic		No. 2 Foundry	
	1935	1936	1935	1936	1935	1936
January	19.00	20.00	18.00	19.00	18.50	19.50
February	19.00	20.00	18.00	19.00	18.50	19.50
March	19.00	20.00	18.00	19.00	18.50	19.50
April	19.00	20.00	18.00	19.00	18.50	19.50
May	19.00	20.00	18.00	19.00	18.50	19.50
June	19.00	20.00	18.00	19.00	18.50	19.50
July	19.00	20.00	18.00	19.00	18.50	19.50
August	19.00	20.00	18.00	19.00	18.50	19.50
September	19.00	20.00	18.00	19.00	18.50	19.50
October	19.00	20.00	18.00	19.00	18.50	19.50
November	20.00	.....	19.00	.....	19.50	.....
December	20.00	.....	19.00	.....	19.50	.....
Year	19.167	.....	18.167	.....	18.667	.....

Iron in dollars per long ton. F.o.b. Mahoning and Shenango Valley furnaces.